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AN APPENDIX TO

A REPORT

ON THE

ROAD DESIGN MANAGEMENT RESEARCH PROJECT

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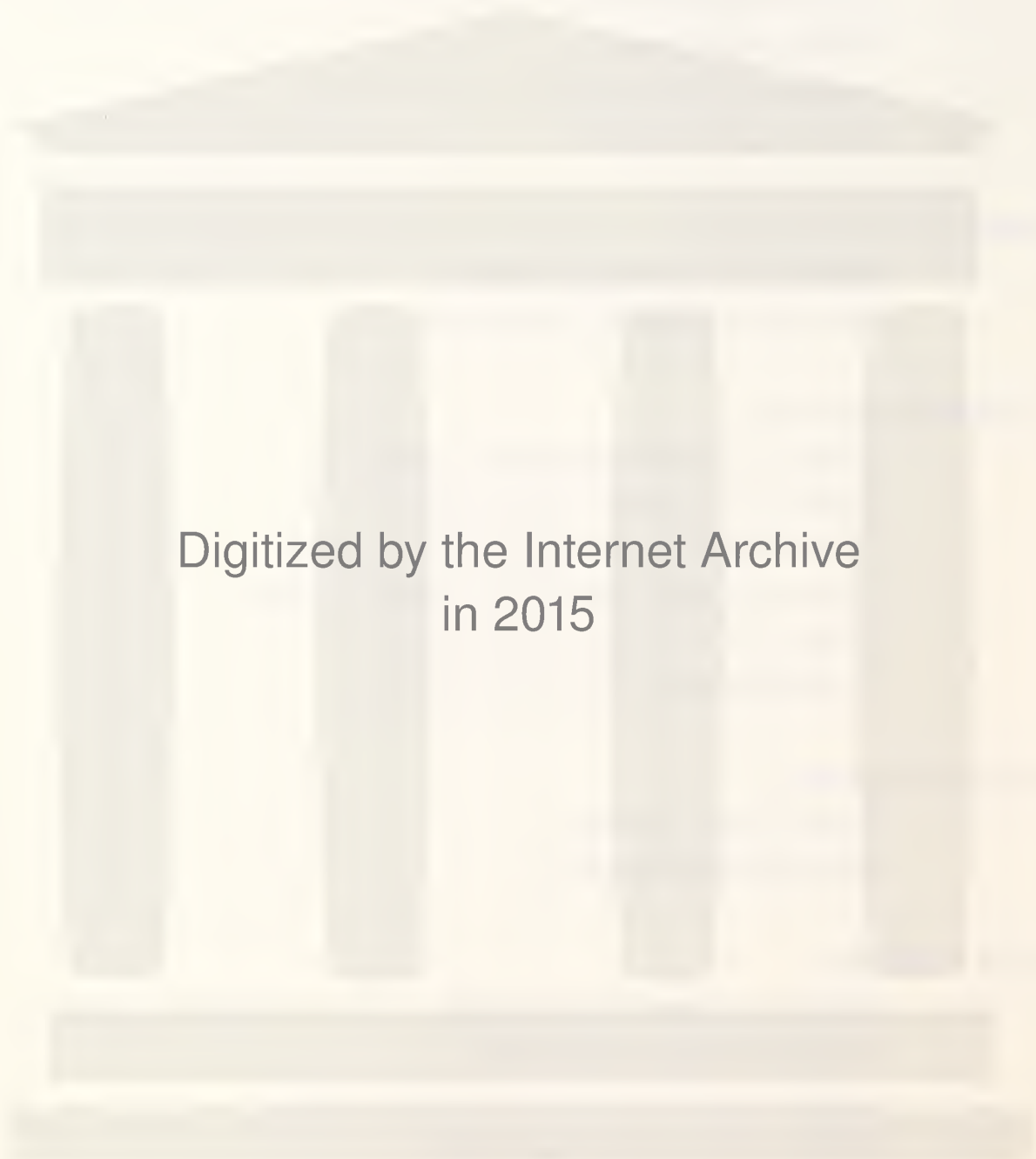

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WORK ACTIVITIES

Work sampling is a fact finding tool. It is a technique that is based on the taking of a large number of observations at random times.

The work sampling program undertaken in the road design function of the Preconstruction Division had three principal objectives. These objectives are as follows:

1. To determine the characteristics, distribution and frequency of road design work activities.

2. To relate observed work activities by level of difficulty to the classifications of personnel performing the work.

3. To relate existing staffing patterns to observed optimum staffing patterns.

The steps undertaken in the work sampling program were as follows:

1. Define the work activities

2. Determine the knowledge, skills and abilities required to effectively perform each activity.

3. Assign each activity a relative level of difficulty.

4. Design the work sampling program, and data processing procedures and reports.

5. Train the observers.

6. Analyze data processing reports.

ACTIVITY TITLES AND CODES
FOR WORK SAMPLING PROGRAM
(continued)

Code	Activity Description
	ROAD DESIGN (continued)
31	Preparing Right-of-Way linens
32	Preparing Right-of-Way sepia
33	Interpreting and plotting property lines
34	Designing Right-of-Way limits
35	Preparing utility plans
36	Reviewing consultant agreements
37	Checking and reviewing plans
	SURFACING DESIGN
40	Determining soil support value
41	Designing structural sections
42	Determining suitable material sources
43	Determining theoretical crush-down
	OFFICE ENGINEERING
60	Developing contract bid item list
61	Preparing engineer's estimate
62	Preparing modified estimate
63	Developing standard city agreements and county resolutions
64	Developing special city agreements and county resolutions
65	Writing final special provisions
66	Preparing proposal package
67	Presenting project to Board of Review
68	Preparing for letting
69	Conducting bid letting and evaluate bids
70	Compiling, reviewing and clearing standard drawings
71	Preparing bid summaries

ACTIVITY TITLES AND CODES
FOR WORK SAMPLING PROGRAM

Code	Activity Description
	ROAD DESIGN
1	Checking notes preparatory to plotting
2	Plotting survey data--aerial and land
3	Plotting cross sections
4	Templating cross sections
5	Designing typical sections
6	Designing alignment and grade
7	Computing grade lines
8	Designing intersection, rest area, scale and interchange geometrics
9	Designing contour grading
10	Designing miscellaneous features
11	Designing clearing and grubbing details
12	Designing fencing
13	Plotting drainage on plan and profile
14	Designing drainage
15	Preparing preliminary estimates
16	Preparing displays and illustrations
17	Participating in field trips
18	Computing areas
19	Computing Right-of-Way areas of taking
20	Computing earthwork quantities (by hand)
21	Plotting mass diagrams (by hand)
22	Totaling final quantities
23	Writing preliminary special provisions
24	Inking final plans
25	Coding basic computer inputs
26	Coding complex inputs
27	Checking and interpreting computer outputs
28	Cross-checking structure and road plans
29	Extending estimates and quantities
30	Plotting construction limits

ACTIVITY TITLES AND CODES
FOR WORK SAMPLING PROGRAM
(continued)

Code	Activity Description
	GENERAL ACTIVITIES
80	Preparing and reviewing correspondence
81	Preparing or reviewing reports
82	Technical research
83	Giving or receiving supervision
84	Preparing time and leave records
85	Preparing progress reports
86	Handling files, supplies and equipment.
87	Other assignments out-of-area, business related
88	Out-of-area, purpose unknown
89	Business related telephone calls
90	Personal time
91	Waiting for assignment
92	No Observation taken
93	Absent from work

EXAMPLE

WORK ACTIVITIES
KNOWLEDGE, SKILL AND ABILITY (KSA) REQUIREMENTS
AND LEVELS OF DIFFICULTY
FOR ROAD DESIGN ACTIVITIES

WORK ACTIVITY	LEVEL OF DIFFICULTY	TYPICAL KNOWLEDGE, SKILL AND ABILITY STATEMENTS
Templating Cross Sections 1. Templating the plotted cross sections 2. Checking templating.	3	Knowledge 1. Of design standards and accepted practices--slope standards, superelevations, roundings, run-off, etc. 2. Of design scales--horizontal and vertical. Skill and Ability 1. To make technical judgments on slopes, changes in profiles, curves and drainage. 2. To spot irregularities in drainage, alignment and grade lines. 3. To perform basic drafting--straight lines, line weights, etc.
Designing Typical Sections 1. Designing sections 2. Calculating quantities from typical sections 3. Arranging quantity data	5	Knowledge 1. Of typical section design standards. 2. Of basic mathematics--arithmetic--highway trigonometry--angles, functions--and geometric figures--triangles. 3. Of design scales--horizontal and vertical. Skill and Ability 1. To interpret basic design data and apply those data to design of typical sections--structural thickness, traffic counts and design speeds, standards, program documents and plan-in-hand reports. 2. To make basic logic checks on construction material types.
Design Alignment and Grade 1. Determining vertical and horizontal location 2. Determining intersection points, grade lines, etc. 3. Determining balance points 4. Recording data on plan and profile sheets	7	Knowledge 1. Of application of design standards--curve selection, design speed, beautification, drainage and right-of-way requirements. 2. Of highway trigonometry--spirals and tables. 3. Of alignment evaluations--costs of alternate curves, space, roadway user costs, special problems (rivers and railroads) and "fish and wildlife conservation". 4. Of existing soil, topography and weather data. Skill and Ability 1. To interpret and apply data processing output information. 2. To select optimum alternative. 3. To visualize the affects of alternate balance points.

PRECONSTRUCTION
WORK SAMPLING
INSTRUCTIONS

Background

Work sampling is a fact finding tool. It has been used with varing degrees of success in both industry and government. Roy Jorgensen Associates, Inc. has conducted several work sampling programs in several states. We have found that well designed, well conducted and properly analyzed work sampling programs yield the desired result.

What is the desired result? Work sampling is a way of measuring how people spend their time at work. Once this is known certain generalizations can be made about (1) the level of staffing and (2) the composition of the staff -- the number of engineers, top level draftsmen, etc.

The observers (that is you) are the key to success. You can, if you do not follow instructions, either knowingly or unknowingly bias (give an untrue picture) the results of the study. So do the job well, carefully and in accordance with the following instructions.

General Guidelines

There are seven basic guidelines:

1. An observation is a work activity picture at a moment in time. Record it accurately.

   You will see people who are not actively engaged. You will see others performing various work activities. Forget what you saw in your last observation. Record what you see the employee doing at the first moment you see him.

   Be completely objective. Be a work activity camera recording work underway as accurately as a camera would.

2. Make observations at the proper time.

   The observation schedule has been developed based on randomly selected times. Statistical validity of the study requires that the observations be taken as close as possible to these selected times. If, for some reason, you miss a scheduled observation time, take the observation as soon as you can. In any case, record the actual time of the observation on the Weekly Record of Observations form in the space provided above the observation number.

3. Do not anticipate a particular action.

   The observer should not attempt to "second guess" a person's activity. If, for example, an individual is momentarily away from his workplace at the time of observation, he should be recorded as such, even though he will be back at his workplace performing some task shortly. By adhearing to the observation

schedule and obtaining a large number of observations, a representative cross-section of the normal work activities will be obtained.

4. Accurate identification of each observation is important.

   Observers are chosen who are knowledgeable in the work activities being performed. However, in certain cases, it may be difficult to identify an employee's work activity. If there is any doubt, ask the employee or crew leader.

5. Avoid any patterns in making observations.

   Try to avoid taking the same route during observations. The employees will begin to anticipate a particular route. This may result in biased observations.

6. Observers should record their own activity.

   Record your work activity at the time work is interupted to make a round of observations.

7. Record addition or loss of personnel or changes in classifications.

   If an employee is added to the group being observed, his name should be added to the "Weekly Record of Observations" in red pencil. If an employee is dropped from the group, cross out his name in red pencil. A change in an employee's classification should be noted in red pencil.

Specific Guidelines

This "package" has everything you will need in making the observation except the observation form itself, and the last page of this handout is a completed example of the form.

The contents of these instructions are:

1. Instructions

   The portion you are now reading.

2. Time Schedule (Figure 1)

   A day-by-day listing of the times you will be expected to make your observations. The observations are the responsibility of the primary observer. If he cannot make it (illness, work overload, etc.) he is expected to make arrangements for the alternate to make the observations.

3. Section and Crew Code Numbers (Figure 2)

   A listing of code numbers to be used on the observation sheet for Section (East Region is 3, for example) and Crew (Nelson's Crew in East Region is 3).

4. Personnel Classification Code Numbers (Figure 3)

   A listing of code numbers to be used on the observation form for Personnel

Classification. For example, a draftsmen III is code number 23.

Each person being observed must be identified by a Section number, a Crew number and a Personnel Classification number.

5. Activity Codes (Figure 4)

A listing of work activities being performed in each of the units being observed. The work the observer sees underway is recorded on the observation form by the codes shown in Figure 4.

6. Observation Form

You will be given a supply of these forms. If you run low call Lance Stapleton or Ed Shaw at 2056.

MAKING THE OBSERVATION

There are seven basic items of information that must be put on the observation sheet. These are (1) the week in which the observation is taken, (2) the section code for each person, (3) the crew to which each person is assigned, (4) the personnel classification of each person, (5) the employee's name who was observed, (6) the time each observation was made and (7) the activity in which each person was engaged during the observation.

Week

Refer to Figure 1 -- "Work Sampling Study Observation Times". The first column on the left has a figure in parenthesis under the date. This is the week of study. Each Monday morning insert the correct number in the WEEK box on the upper left hand corner of the form.

Example: Assume the date is Monday September 28. The proper entry is

WEEK

1

1-2

If the week were November 9, the proper week number would be 7.

Section and Crew Codes

Your observation forms will have the section and crew codes preprinted. However, changes do occur. The section and crew codes are listed in Figure 2. The section number goes in the first column on the left. The crew number goes in the second column.

Example: Assume Joe Flyash is transferred into a section you are observing. He will be assigned to Stoner's Crew in East Region. Refer to Figure 2. The

Section Code for East Region is 3. The Crew code for Stoner's Crew is 4. Show it like this:

Section	Crew
3	4
3-4	5-6

Personnel Classification

Personnel Classification codes are shown in Figure 3. The code numbers to be used are shown in the column on the left.

Example: Assume Joe Flyash is a Detailer II. The code number as shown in Figure 3 is 12. Put the number in the "Class" column as follows:

Class
12

Name

Insert Joe Flyash's name in the "Employee Name" column. Don't worry whether his name is Joe, Josepee, Josephine or whatever. It is only used so that you can identify him when making the observations.

Observation Time

Figure 1, "Observation Times", gives the times you are to make each observation. The month and day column gives the date of each week beginning on Monday. The first week of study begins on September 28.

There are three schedules, each is different and each is intended for use by observers or alternates on one floor of the building.

Example: Assume the date is October 13. Refer to Figure 1 for the third floor. The observation times are 9:45, 10:20, 2:15 and 3:55. Assume you made each observation on schedule. You would show it this way:

Week	Tuesday			
3	9:45	10:20	2:15	3:55
1-2	One	Two	Three	Four

If your actual time of observation varies from the schedule record the time you actually started the observation, to the nearest 5 minutes. In the example assume the first observation was not started until 10:00. Record 10:00 rather than the scheduled time of 9:45.

THE OBSERVATION TIMES, Figure 1, ARE FOR YOUR USE ONLY. NO ONE ELSE SHOULD SEE THEM OR GET COPIES OF THEM. This is necessary to assure unbiased results from the study.

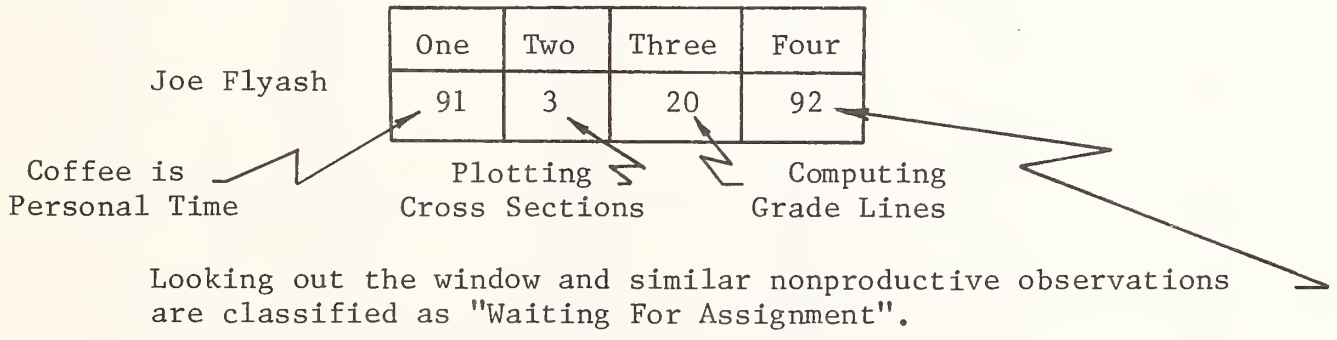
Recording the Activity

Figure 4 is a listing of the work activities to be used in the work sampling study. You will record the number of the activity on the observation form across from the person's name in the proper column.

Note that Figure 4 is divided into three major sections. These sections are for your convenience. They are General Activities, Road Design Activities and Office Engineering Activities. You may use any activity in any section that describes the work underway. If, for example, a detailer in East Region is assisting in preparing the engineer's estimate, use that code even though it appears under Office Engineering Activities.

In making the observation make one decision as soon as you see the people being observed. Decide whether or not each person is actively engaged in work. Record those who are not, and then determine what kind of work those actively engaged were doing and place the proper code on the observation sheet.

Example: Assume you observed Joe Flyash four times. The first time he was having coffee, the second time he was plotting cross sections, the third time he was computing grade lines and the last time he was just looking out the window. You would record the observations in the following manner:



You will need to be familiar with all activities. The ones used most frequently will soon be memorized. After a couple of weeks you will find that you need to make reference to the activity listings only infrequently.

Date processing can't stand blank spaces. If there are periods in which observations are not taken, holidays, etc., enter code 93, no observation taken.

Section Code for East Region is 3. The Crew code for Stoner's Crew is 4. Show it like this:

Section	Crew
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3-4	5-6

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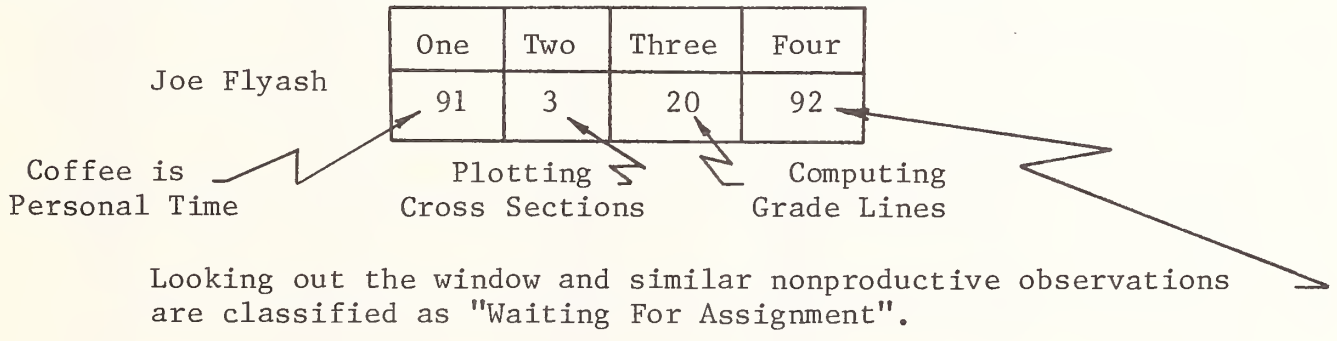

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Date processing can't stand blank spaces. If there are periods in which observations are not taken, holidays, etc., enter code 93, no observation taken.

FIGURE 1

MONTANA HIGHWAY DEPARTMENT

WORK SAMPLING STUDY
OBSERVATION TIMES
FOR THIRD FLOOR

MONTH AND DAY (WEEK OF STUDY)	DAY OF STUDY	FIRST OBSERVATION	SECOND OBSERVATION	THIRD OBSERVATION	FOURTH OBSERVATION
9/28/70 (1)	1	9:00	1:40	2:55	4:20
	2	9:10	9:45	10:55	3:10
	3	10:10	1:25	3:15	4:05
	4	9:00	1:10	3:15	4:00
	5	10:40	2:05	3:25	4:25
10/05/70 (2)	6	8:35	10:45	1:45	3:20
	7	8:55	1:25	2:35	4:20
	8	9:05	10:10	2:00	3:05
	9	10:25	1:15	2:20	3:40
	10	8:35	10:05	1:00	2:40
10/12/70 (3)	11	8:35	9:35	2:10	2:55
	12	9:45	10:20	2:15	3:55
	13	8:05	2:00	2:45	3:50
	14	9:50	10:55	1:55	4:00
	15	8:00	8:55	11:35	3:15
10/19/70 (4)	16	8:50	9:40	10:55	1:45
	17	8:25	10:10	1:15	3:10
	18	8:35	2:00	2:45	4:30
	19	8:25	1:20	2:55	4:25
	20	8:20	11:35	2:00	3:05
10/26/70 (5)	21	8:00	10:15	3:10	4:30
	22	8:35	9:20	2:50	4:05
	23	8:55	9:30	11:25	3:45
	24	9:30	11:00	2:10	4:00
	25	9:20	10:35	2:15	4:05
11/02/70 (6)	26	8:40	9:55	2:35	3:35
	27	8:05	9:35	3:05	4:40
	28	9:05	10:50	11:30	1:55
	29	8:55	10:30	2:05	3:20
	30	9:10	10:45	3:05	4:05
11/09/70 (7)	31	9:35	10:45	1:00	2:00
	32	9:30	10:00	2:35	3:35
	33	9:05	10:00	11:20	1:10
	34	10:55	1:35	3:20	4:05
	35	8:15	8:55	11:20	2:45
11/16/70 (8)	36	8:30	9:20	11:15	1:15
	37	8:35	10:40	2:15	3:00
	38	9:55	10:40	11:20	2:00
	39	9:00	10:30	1:00	4:15
	40	9:45	10:35	3:05	4:15
11/23/70 (9)	41	8:15	11:15	2:15	3:20
	42	8:10	10:35	1:55	3:25
	43	8:05	2:30	3:10	4:10
	44	9:15	10:45	11:20	4:10
	45	8:20	11:30	1:30	2:45
11/30/70 (10)	46	8:05	11:20	1:45	2:20
	47	9:20	2:20	3:00	3:45
	48	9:15	10:30	2:05	4:25
	49	8:00	9:30	1:55	3:55
	50	8:35	9:20	2:45	4:05

WEEK
1-2

WORK SAMPLING STUDY
WEEKLY RECORD OF OBSERVATIONS

SECT.	CREW	CLASS.	EMPLOYEE NAME	MONDAY				TUESDAY				WEDNESDAY				THURSDAY				FRIDAY			
				1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
3-4	5-6	7-8		10-11	12-13	14-16	16-17	20-21	22-23	24-25	26-27	30-31	32-33	34-35	36-37	40-41	42-43	44-45	46-47	50-51	52-53	54-55	56-57

EXAMPLE REPORT BY ACTIVITY

WEEKLY WORK SAMPLING REPORT
DISTRIBUTION OF WORK ACTIVITIES
BY ACTIVITY

WEEK NO 10

ACTIVITY NUMBER	PREVIOUS NUMBER	PREVIOUS PERCENT	CURRENT NUMBER	CURRENT PERCENT	TOTAL TO DA NUMBER	TOTAL TO DA PERCENT
01	49	0.4	2	0.1	51	0.3
02	239	1.8	39	2.4	278	1.9
03	252	1.9	13	0.8	265	1.8
04	266	2.0	43	2.6	309	2.1
05	129	1.0	8	0.5	137	0.9
06	253	1.9	18	1.1	271	1.8
07	33	0.2	7	0.4	40	0.3
08	108	0.8	16	1.0	124	0.8
09	88	0.7	7	0.4	95	0.6
10	145	1.1	19	1.2	164	1.1
12	16	0.1	4	0.2	20	0.1
13	45	0.3	11	0.7	56	0.4
14	155	1.2	10	0.6	165	1.1
15	44	0.3	5	0.3	49	0.3
16	103	0.8	2	0.1	105	0.7
17	330	2.5	27	1.6	357	2.4
18	62	0.5	9	0.5	71	0.5
19	252	1.9	45	2.7	297	2.0
20	183	1.4	42	2.6	225	1.5
21	59	0.4	2	0.1	61	0.4
22	227	1.7	32	2.0	259	1.7
23	10	0.1	0	0.0	10	0.1
24	627	4.7	108	6.6	735	4.9
25	7	0.1	0	0.0	7	0.0
26	64	0.5	5	0.3	69	0.5
27	103	0.8	7	0.4	110	0.7
28	10	0.1	0	0.0	10	0.1
29	19	0.1	0	0.0	19	0.1
30	85	0.6	42	2.6	127	0.8
31	46	0.3	18	1.1	64	0.4
32	36	0.3	1	0.1	37	0.2
33	106	0.8	12	0.7	118	0.8
34	96	0.7	21	1.3	117	0.8
35	54	0.4	8	0.5	62	0.4
36	0	0.0	2	0.1	2	0.0
37	559	4.2	98	6.0	657	4.4
40	12	0.1	0	0.0	12	0.1
41	34	0.3	6	0.4	40	0.3
42	32	0.2	6	0.4	38	0.3
43	2	0.0	0	0.0	2	0.0
60	61	0.5	9	0.5	70	0.5
61	85	0.6	18	1.1	103	0.7
62	21	0.2	2	0.1	23	0.2
63	7	0.1	1	0.1	8	0.1
64	2	0.0	1	0.1	3	0.0
65	50	0.4	5	0.3	55	0.4
66	82	0.6	1	0.1	83	0.6
67	0	0.0	4	0.2	4	0.0
68	25	0.2	0	0.0	25	0.2

EXAMPLE REPORT BY ACTIVITY

WEEKLY WORK SAMPLING REPORT
DISTRIBUTION OF WORK ACTIVITIES
BY ACTIVITY

WEEK NO 10

ACTIVITY NUMBER	PREVIOUS NUMBER	PREVIOUS PERCENT	CURRENT NUMBER	CURRENT PERCENT	TOTAL TO DA NUMBER	TOTAL TO DA PERCENT
69	15	0.1	1	0.1	16	0.1
70	124	0.9	13	0.8	137	0.9
71	1	0.0	0	0.0	1	0.0
80	265	2.0	55	3.4	320	2.1
81	194	1.5	23	1.4	217	1.4
82	312	2.3	44	2.7	356	2.4
83	593	4.4	86	5.2	679	4.5
84	93	0.7	20	1.2	113	0.8
85	31	0.2	3	0.2	34	0.2
86	513	3.8	71	4.3	584	3.9
87	817	6.1	90	5.5	907	6.0
88	318	2.4	25	1.5	343	2.3
89	98	0.7	21	1.3	119	0.8
90	2034	15.2	208	12.7	2242	14.9
91	744	5.6	75	4.6	819	5.5
93	1934	14.5	168	10.3	2102	14.0
TOTAL	13359	100.2	1639	100.1	14998	100.1

EXAMPLE REPORT BY CLASSIFICATION

WEEKLY WORK SAMPLING REPORT
DISTRIBUTION OF WORK ACTIVITIES
BY CLASSIFICATION

WEEK NO 10

CLASSIFICATION CODE	ACTIVITY CODE	PREVIOUS TOTAL NUMBER	PREVIOUS TOTAL PERCENT	CURRENT TOTAL NUMBER	CURRENT TOTAL PERCENT	TOTAL TO DATE NUMBER	TOTAL TO DATE PERCENT
03	86	80	3.5	5	1.8	85	3.3
03	87	157	6.9	18	6.5	175	6.8
03	88	46	2.0	5	1.8	51	2.0
03	89	30	1.3	11	3.9	41	1.6
03	90	355	15.6	47	16.8	402	15.7
03	91	121	5.3	10	3.6	131	5.1
03	93	371	16.3	32	11.5	403	15.7
TOTAL		2283	99.9	279	100.0	2562	100.1
09	02	1	0.2	0	0.0	1	0.1
09	06	0	0.0	1	1.3	1	0.1
09	07	1	0.2	0	0.0	1	0.1
09	08	2	0.3	0	0.0	2	0.3
09	10	1	0.2	0	0.0	1	0.1
09	15	2	0.3	2	2.5	4	0.5
09	16	3	0.5	0	0.0	3	0.4
09	17	82	12.6	13	16.3	95	13.0
09	27	1	0.2	0	0.0	1	0.1
09	80	66	10.2	14	17.5	80	11.0
09	81	64	9.9	2	2.5	66	9.0
09	82	36	5.5	4	5.0	40	5.5
09	83	79	12.2	15	18.8	94	12.9
09	84	1	0.2	0	0.0	1	0.1
09	85	6	0.9	0	0.0	6	0.8
09	86	26	4.0	7	8.8	33	4.5
09	87	80	12.3	12	15.0	92	12.6
09	88	32	4.9	1	1.3	33	4.5
09	89	14	2.2	4	5.0	18	2.5
09	90	76	11.7	1	1.3	77	10.5
09	91	19	2.9	2	2.5	21	2.9
09	93	58	8.9	2	2.5	60	8.2
TOTAL		650	100.2	80	100.3	730	99.7

EXAMPLE REPORT BY SECTION

WEEKLY WORK SAMPLING REPORT
DISTRIBUTION OF WORK ACTIVITIES
BY SECTION

WEEK NO 10

SECTION NUMBER	CLASS CODE	ACTIVITY CODE	PREVIOUS TOTAL NUMBER	PREVIOUS TOTAL PERCENT	CURRENT TOTAL NUMBER	CURRENT TOTAL PERCENT	TOTAL TO DATE NUMBER	TOTAL TO DATE PERCENT
01	12	02	11	1.8	5	6.3	16	2.
01	12	06	9	1.5	0	0.0	9	1.3
01	12	16	0	0.0	1	1.3	1	0.1
01	12	24	14	2.3	1	1.3	15	2.2
01	12	29	3	0.5	0	0.0	3	0.4
01	12	37	4	0.7	0	0.0	4	0.6
01	12	81	1	0.2	0	0.0	1	0.1
01	12	82	1	0.2	0	0.0	1	0.1
01	12	83	3	0.5	0	0.0	3	0.4
01	12	84	23	3.8	5	6.3	28	4.1
01	12	85	5	0.8	0	0.0	5	0.7
01	12	86	10	1.6	1	1.3	11	1.6
01	12	87	14	2.3	3	3.8	17	2.5
01	12	88	1	0.2	0	0.0	1	0.1
01	12	89	2	0.3	0	0.0	2	0.3
01	12	90	24	3.9	1	1.3	25	3.6
01	12	91	1	0.2	0	0.0	1	0.1
01	12	93	36	5.9	3	3.8	39	5.7
SUBTOTAL			162	26.7	20	25.4	182	26.2
01	21	24	79	13.0	14	17.5	93	13.5
01	21	83	4	0.7	1	1.3	5	0.7
01	21	86	11	1.8	1	1.3	12	1.7
01	21	87	7	1.1	2	2.5	9	1.3
01	21	90	15	2.5	2	2.5	17	2.5
01	21	91	2	0.3	0	0.0	2	0.3
01	21	93	6	1.0	0	0.0	6	0.9
SUBTOTAL			124	20.4	20	25.1	144	20.9
01	22	24	98	16.1	13	16.3	111	16.1
01	22	83	2	0.3	0	0.0	2	0.3
01	22	84	1	0.2	0	0.0	1	0.1
01	22	86	8	1.3	1	1.3	9	1.3
01	22	87	3	0.5	0	0.0	3	0.4
01	22	88	5	0.8	0	0.0	5	0.7
01	22	89	1	0.2	0	0.0	1	0.1
01	22	90	18	3.0	4	5.0	22	3.2
01	22	91	7	1.1	0	0.0	7	1.0
01	22	93	19	3.1	2	2.5	21	3.0
SUBTOTAL			162	26.6	20	25.1	182	26.2

EXAMPLE REPORT BY CREW

WEEKLY WORK SAMPLING REPORT
DISTRIBUTION OF WORK ACTIVITIES
BY CREW

WEEK NO 10

SECTION SECT	NUMBER CREW	CLASS CODE	ACTIVITY CODE	PREVIOUS TOTAL NUMBER	PREVIOUS TOTAL PERCENT	CURRENT TOTAL NUMBER	CURRENT TOTAL PERCENT	TOTAL TO DATE NUMBER	TOTAL TO DATE PERCENT
08	05	31	93	0	0.0	2	2.0	2	0.3
TOTAL				642	100.8	100	100.0	742	99.3
09	01	09	02	1	0.2	0	0.0	1	0.1
09	01	09	06	0	0.0	1	1.3	1	0.1
09	01	09	07	1	0.2	0	0.0	1	0.1
09	01	09	08	2	0.3	0	0.0	2	0.3
09	01	09	10	1	0.2	0	0.0	1	0.1
09	01	09	15	2	0.3	2	2.5	4	0.5
09	01	09	16	3	0.5	0	0.0	3	0.4
09	01	09	17	82	12.6	13	16.3	95	13.0
09	01	09	37	1	0.2	0	0.0	1	0.1
09	01	09	60	66	10.2	14	17.5	80	11.0
09	01	09	81	64	9.8	2	2.5	66	9.0
09	01	09	82	36	5.5	4	5.0	40	5.5
09	01	09	83	79	12.2	15	18.8	94	12.9
09	01	09	84	1	0.2	0	0.0	1	0.1
09	01	09	85	6	0.9	0	0.0	6	0.8
09	01	09	86	26	4.0	7	8.8	33	4.5
09	01	09	87	80	12.3	12	15.0	92	12.6
09	01	09	88	32	4.9	1	1.3	33	4.5
09	01	09	89	14	2.2	4	5.0	18	2.5
09	01	09	90	76	11.7	1	1.3	77	10.5
09	01	09	91	19	2.9	2	2.5	21	2.9
09	01	09	93	58	8.9	2	2.5	60	8.2
TOTAL				650	100.2	80	100.3	730	99.7

FIGURE 1

ROAD DESIGN

SUMMARY OF LEVELS OF DIFFICULTY

(SEPTEMBER 28, 1970 THROUGH DECEMBER 4, 1970)

DIRECT & SUPPORTING ACTIVITIES[1/]	NUMBER OF OBSERVATIONS	% OF GROUP	% OF TOTAL
Level One	1,323	20.6	8.8
Level Two	803	12.5	5.4
Level Three	1,192	18.6	7.9
Level Four	678	10.6	4.5
Level Five	2,418	37.7	16.1
Subtotal	6,414	100.0	42.8
LEVELS NOT DEFINED			
Supporting & Nonproductive Activities	6,482	75.5	43.2
Leave	2,102	24.5	14.0
Subtotal	8,584	100.0	57.2
Total	14,998		100.0

1/ Includes All Activities Which Have A Level Of Difficulty Assigned.

SUMMARY OF LEVELS OF DIFFICULTY

Figure 1

This figure illustrates the characteristics of the design work load by level of difficulty. The data indicated that approximately 43per cent of the on-the-job time spent by design personnel was utilized in direct production or those supporting activities for which a level of difficulty could be assigned. The data also indicated that 57 per cent of the time was spent in indirect nonproductive and other supporting activities as well as on leave. The time spent on direct and supporting activities -- those which are assigned a level of difficulty -- is of prime concern.

Level one work -- that work which can be performed by personnel with little or no experience -- comprised approximately 9 per cent of the total work. Further, this type of work comprises approximately 21 per cent of the direct and supporting work load.

Level two work -- that work which can be performed by personnel with limited experience -- comprised 5 per cent of the total work and 12 per cent of the direct and supporting work load.

Level three work -- that work which can be performed by experienced technician personnel requiring close supervision -- comprised 8 per cent of the total work and 19 per cent of the direct and supporting work load.

Level four work -- that work which can be performed by technician personnel requiring limited supervision -- comprised 5 per cent of the total work and 11 per cent of the direct and supporting work load.

Level five work -- that work which can be performed by high level technician or engineering personnel responsible for project design -- comprised 16 per cent of the total work and 38 per cent of the direct and supporting work load.

FIGURE 2

ROAD DESIGN

LEVELS OF DIFFICULTY

BY PERSONNEL CLASSIFICATION

(SEPTEMBER 28, 1970 THROUGH DECEMBER 4, 1970)

PERSONNEL CLASSIFICATION	NUMBER OF OBSERVATIONS[1]	- - -LEVELS OF DIFFICULTY- - - (PERCENT) ONE	TWO	THREE	FOUR	FIVE
Draftsman I and II	1,195	52%	11%	18%	9%	10%
Draftsman III	1,143	40	22	23	6	9
Detailer I and II	907	15	15	16	17	37
Designer I	861	5	11	22	15	47
Designer II	639	4	8	16	17	55
Designer III	920	1	7	9	8	75
Engineer-in-Training[2]	183	23	32	15	3	27
Estimates Supervisor I and III	280	--	2	55	6	37
Area Engineer, Special Assignments Engineer I and Contract Plans Manager	286	--	3	5	1	91
Totals and Averages	6,414	21%	12%	19%	10%	38%

1/ Includes All Activities Which Have A Level Of Difficulty Assigned -- Direct Work Activities And Selected Supporting Activities.

2/ Four Personnel Were Transferred Out Of Preconstruction And One Person Was Transferred Into Preconstruction During The Study.

LEVELS OF DIFFICULTY BY PERSONNEL CLASSIFICATION

Figure 2

This figure illustrates the distribution of direct work activities and selected supporting activities accomplished by the personnel classification studied. The distribution of work by level of difficulty varied from 10 per cent to 38 per cent as illustrated in Figure 1 and the average percents in Figure 2.

The distribution of work for each of the classifications is illustrated by the percentages of work effort by level of difficulty. It is important to note that the majority of the classifications performed work in each of the levels of difficulty. (There were no level one work activities for Office Engineer personnel.) Ideally, each of the personnel in a classification would perform work only in the highest level of difficulty which his capability permitted. Realistically, variations from this optimum are common and to be expected. To a limited extent, personnel can perform adequately work at higher levels than those normally associated with their personnel classification when receiving very close supervision.

Variations to the extent indicated in Figure 2 can be caused by at least two situations (1) crew staffing patterns not developed to match the existing work load, and (2) personnel not properly classified according to their capability to perform.

FIGURE 3

ROAD DESIGN

AVERAGE LEVEL OF DIFFICULTY

FOR DIRECT AND SUPPORTING ACTIVITIES

BY PERSONNEL CLASSIFICATION

PERSONNEL CLASSIFICATION	NUMBER OF OBSERVATIONS	WEIGHTED AVERAGE LEVEL OF PERFORMANCE
Draftsman I and II	1,195	2.2
Draftsman III	1,143	2.2
Detailer I and II	907	3.4
Designer I	861	3.9
Designer II	639	4.1
Designer III	920	4.5
Engineer-v-Training 1/	183	2.8
Estimates Supervisor I and III	280	3.8
Area Engineer, Special Assignments Engineer I And Contract Plans Manager	286	4.8

1/ Four Personnel Were Transferred Out Of Preconstruction And One Person Was Transferred Into Preconstruction During The Study.

AVERAGE LEVEL OF DIFFICULTY

BY PERSONNEL CLASSIFICATION

Figures 3 & 4

Figure 3 illustrates the weighted average level of performance for direct and selected supporting activities for each of the personnel classifications studied.

The average level of performance increases from the Detailer I classification through the Designer III classification. Work performed by personnel in the Engineer-in-Training classification was performed at an average level of performance less than that of the Detailer I and II classifications.

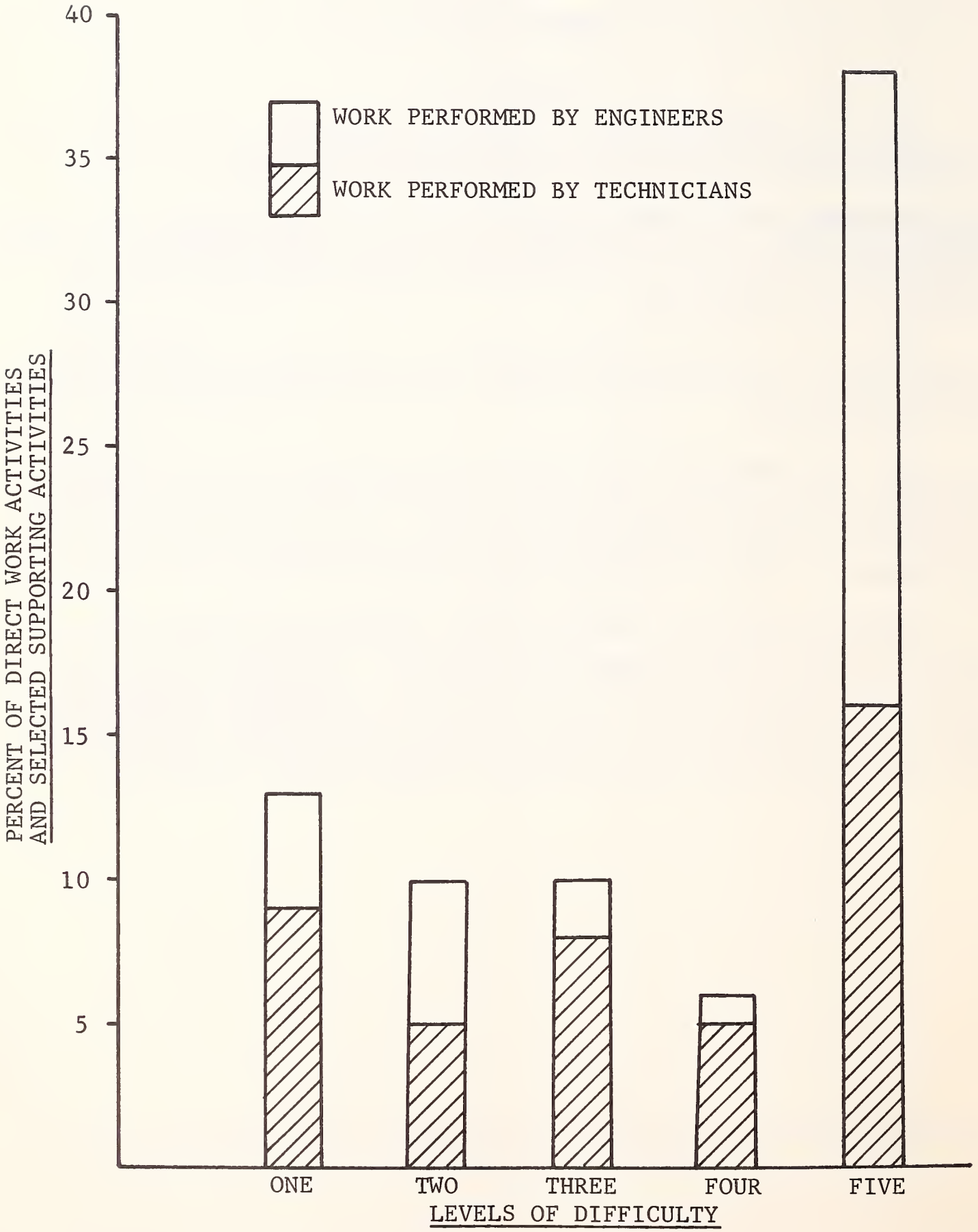
Personnel in the administrative classifications -- Area Engineer, Special Assignments Engineer I and Contract Plans Manager -- performed work at the highest average level of performance.

Figure 4 illustrates the per cent of direct work activities and selected supporting activities -- those activities to which a level of difficulty could be assigned -- by levels of difficulty performed by engineers and technicians. For the purposes of this analysis, Engineers were defined as graduates in directly related engineering curriculum and those with E.I.T. status or Professional Engineering license.

The bar graph indicates the relative amounts of work performed in each of the levels of difficulty by both the engineers and technicians. For example, 22 per cent of the work performed in the highest level of difficulty as opposed to 1 per cent in the fourth level of difficulty and 4 per cent in the lowest level of difficulty. It should be noted, that the work performed by the personnel in the Engineer-in-Training classification was at a lower average level of difficulty than that of the other Engineer classifications.

FIGURE 4

LEVELS OF DIFFICULTY PERFORMANCE BY CLASSIFICATION GROUP



STAFFING ANALYSIS

Figures 5 and 6

The characteristics of the design work load, as documented by work sampling, indicated that (1) 38 per cent of the work was performed in the highest level of difficulty, (2) 10 per cent was performed in the fourth level of difficulty, (3) 19 per cent was performed in the third level of difficulty, (4) 12 per cent was performed in the fourth level of difficulty, and (5) that 21 per cent was performed in the lowest level of difficulty. A correctly developed staffing pattern would balance a properly classified staff with the work to be accomplished.

The existing staffing pattern is out of balance with the work load distribution as documented by the work sampling program. For example, there are 6 Engineers and 14 Designers which represents 27 per cent of the total personnel -- a deviation of 11 per cent from the work load requirement. Further, there are 9 Detailers I and 13 Draftsmen III representing 29 percent of the total staff and a deviation of 17 per cent from the work load distribution.

An alternative staffing pattern is shown which utilizes approximately the same number of total personnel. This staffing pattern represents a staff balanced with the work to be accomplished.

The work load distribution and the existing staffing pattern shown in Figure 6 duplicates the data shown on Figure 5, but demonstrates alternates in the number of persons employed.

A different staffing pattern alternative is depicted which is based on a total staff of 65 -- a 15 per cent reduction from the first staffing pattern alternative. The staffing pattern is still balanced to the work load distribution. The point of these alternative staffing patterns is to demonstrate that given a decision establishing the total number of personnel, work sampling will allow one to develop a balanced staffing pattern.

It is important to recognize that the work load distribution was documented under the existing work system. A portion of the current contract is directed toward work systems improvements, and may result in changing the work load distribution to a significant degree. Therefore, no staffing recommendations are made now. However, initial steps can be taken to adjust staffing levels and to evaluate personnel classification and manpower management practices with the assistance of the work sampling results.

FIGURE 5

MANPOWER STAFFING ANALYSIS FOR ROAD DESIGN

LEVEL OF DIFFICULTY AND CLASSIFICATION	WORK LOAD DISTRIBUTION PER WORK SAMPLING (PERCENT)	EXISTING STAFFING PATTERN				STAFFING PATTERN ALTERNATIVE			
		NUMBER OF PERSONS	PERCENT OF FORCE	DEVIATION FROM WORK LOAD (PERCENT)	CUMULATIVE DEVIATION 1/ FROM WORK LOAD (PERCENT	NUMBER OF PERSONS	PERCENT OF FORCE	DEVIATION FROM WORK LOAD (PERCENT)	CUMULATIVE DEVIATION 1/ FROM WORK LOAD (PERCENT)
Level Five	38								
Engineers		6	27	-11	-11	9	38	0	0
Designer III		14				20			
Level Four	10								
Designer II		7	9	- 1	-12	8	11	+1	+1
Level Three	19								
Designer I		11	16	- 3	-15	12	18	-1	0
Detailer II		1				2			
Level Two	12								
Detailer I		9	29	+17	+ 2	4	13	+1	+1
Draftsman III		13				6			
Level One	21								
Draftsman II		13	19	- 2	0	13	20	-1	0
Draftsman I		1				2			
Total Engineers		6				9			
Total Technicians		69				67			
Total Personnel		75				76			

1/ The Assumption Is Made That The Deviation Will Be Cumulative. In Actual Situations, Persons In The Higher Classifications Usually Will Perform Work In Each Of The Lower Levels Of Difficulty, Causing The Deviations To Increase Over Those Shown. Also, Any Deviation From These Averages Toward Temporary Increase In The Engineering Work Load Will Increase The Need For Engineers In Proportion To Technicians.

FIGURE 6

MANPOWER STAFFING ANALYSIS FOR ROAD DESIGN

LEVEL OF DIFFICULTY AND CLASSIFICATION	WORK LOAD DISTRIBUTION PER WORK SAMPLING (PERCENT)	EXISTING STAFFING PATTERN: NUMBER OF PERSONS	EXISTING STAFFING PATTERN: PERCENT OF FORCE	EXISTING STAFFING PATTERN: DEVIATION FROM WORK LOAD (PERCENT)	EXISTING STAFFING PATTERN: CUMULATIVE DEVIATION[1] FROM WORK LOAD (PERCENT)	STAFFING PATTERN ALTERNATIVE: NUMBER OF PERSONS	STAFFING PATTERN ALTERNATIVE: PERCENT OF FORCE	STAFFING PATTERN ALTERNATIVE: DEVIATION FROM WORK LOAD (PERCENT)	STAFFING PATTERN ALTERNATIVE: CUMULATIVE DEVIATION[1] FROM WORK LOAD (PERCENT)
Level Five	38								
Engineers		6	27	-11	-11	3	38	0	0
Designer III		14				17			
Level Four	10								
Designer II		7	9	- 1	-12	7	11	+1	+1
Level Three	19								
Designer I		11	16	- 3	-15	10	19	0	+1
Detailer II		1				2			
Level Two	12								
Detailer I		9	29	+17	+ 2	3	12	0	+1
Draftsman III		13				5			
Level One	21								
Draftsman II		13	19	- 2	0	11	20	-1	0
Draftsman I		1				2			
Total Engineers		6				8			
Total Technicians		69				57			
Total Personnel		75				65			

1/ The Assumption Is Made That The Deviation Will Be Cumulative. In Actual Situations, Persons In The Higher Classifications Usually Will Perform Work In Each Of The Lower Levels Of Difficulty, Causing The Deviations To Increase Over Those Shown. Also, Any Deviation From These Averages Toward Temporary Increase In The Engineering Work Load Will Increase The Need For Engineers In Proportion To Technicians.

PLANS STANDARDIZATION

Plans standardization was accomplished through a sheet-by-sheet, and item-by-item analysis of data presented on the plans. The objectives of this analysis were (1) to reduce or eliminate unnecessary or duplicate data, and (2) to improve the information presented on the plans.

The results of this work are shown on the following sheets. The first two sheets are examples before the improvement was undertaken, the second two sheets are examples of the improved plan sheets.

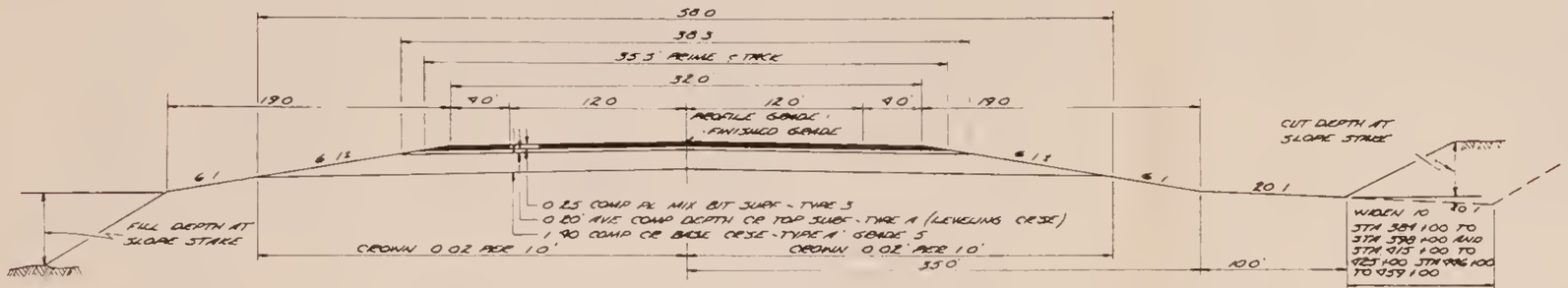
SUMMARY NO. 3

FAP F 233(24) 4 119

TYPICAL SECTION NO. 6

STA 288+16.7 O.E. =
STA 351+22.1 AH TO 289,000
STA 369+00.0 TO 430+88.0
STA 430+48.0 TO 432+48.0 TRANS NO 6 TO NO 2
STA 430+52.0 TO 459+00.0
STA 557+03.9 TO 560+03.9 TRANS TYP 6 TO TYP NO 9
STA 568+85.9 TO 621+00.0

SEE STD SHEET NO 31 FOR CUT & FILL SLOPES AND STD DWG NO 11.02 FOR BACKSLOPE ROUNDING



QUANTITIES

GRAVEL

	PL MIX BITUM SURF TYPE 3	CR TOP SURF TYPE A	CR BASE CRSE TYPE A GR 5
AREA 30 FT	8 938	7 380	67 910
CY PER STA	31 250	27 333	249 667
TONS PER STA	* 62 785	43 733	399 467
TONS PER MILE	* 331530	230911	21,091 9

* INCL WEIGHT OF BITUM MAT'L
+ TO BE APPLIED BETWEEN LIFTS OF PL MIX BITUM SURF

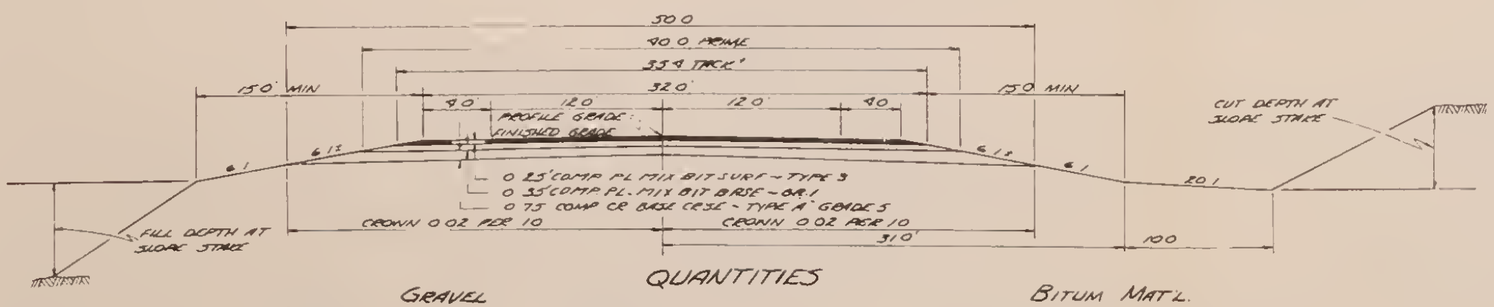
BITUM. MAT'L.

	PL MIX	PRIME	TACK +
SQ YDS PER STA	375 000	399 999	399 999
TONS PER STA	4 081	0 303	
TONS PER MILE	215.5	26 6	
GALS PER STA			39 999
GALS PER MILE			2082 6

TYPICAL SECTION NO. 7

STA 459+00 OTO 473+50
STA 473+50 TO 479+00 TRANS NO 7 TO NO 8
STA 496+00 TO 501+20
STA 501+20 TO 503+00 TRANS NO 7 TO NO 8

SEE STD SHEET NO 31 FOR CUT & FILL SLOPES AND STD DWG NO 11.02 FOR BACKSLOPE ROUNDING



QUANTITIES

GRAVEL

	PL MIX BITUM SURF TYPE 3	PL MIX BITUM BASE	CR BASE CRSE TYPE A GR 5
AREA 30 FT	8 925	13 195	33 750
CY PER STA	31 209	48 870	125 000
TONS PER STA	* 62 692	* 91 631	200 000
TONS PER MILE	* 33101	* 9.030 1	10.3600

* INCL WEIGHT OF BITUM MAT'L
+ TO BE APPLIED BETWEEN LIFTS OF BITUM SURF & BETWEEN PL MIX BIT SURF & PL MIX BIT BASE

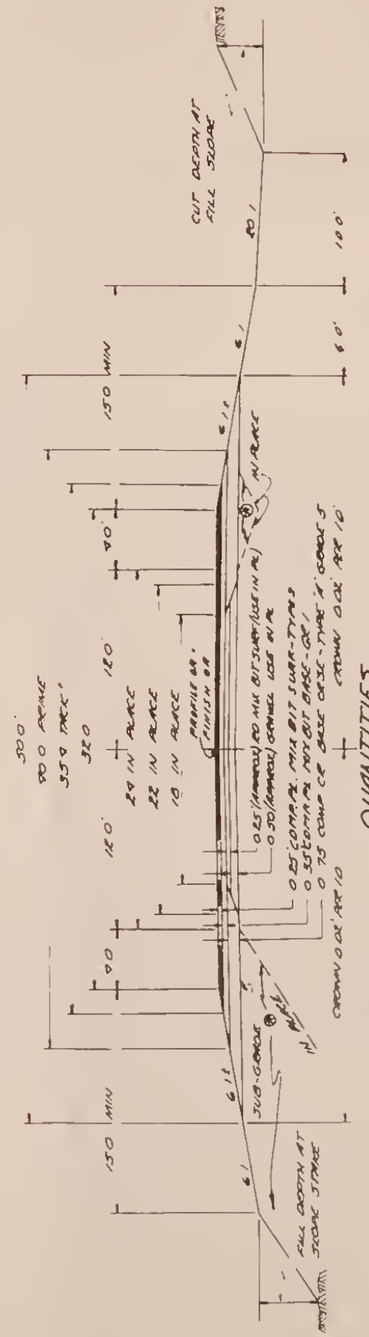
BITUM MAT'L.

	PL MIX SURF TYPE 3	PL MIX BITUM BASE	PRIME	TACK +
SQ YDS PER STA	379 999	408 089	999 999	393 333
TONS PER STA	4 075	4 302	0 367	
TONS PER MILE	215.2	201 9	29 9	
GALS PER STA				39 333
GALS PER MILE				2076 8

TYPICAL SECTION NO. 8

STA 551+00 TO 557+00
STA 568+00 TO 573+00
STA 621+00 TO 625+00
STA 625+00 TO 629+00
STA 629+00 TO 633+00
STA 633+00 TO 639+00
STA 639+00 TO 643+00
STA 643+00 TO 647+00
STA 647+00 TO 651+00
STA 651+00 TO 655+00
STA 655+00 TO 659+00

SEE STD SHEET NO 31 FOR CUT & FILL SLOPES AND STD DWG NO 11.02 FOR BACKSLOPE ROUNDING



QUANTITIES

GRAVEL

	PL MIX BITUM SURF TYPE 3	PL MIX BITUM BASE	CR BASE CRSE TYPE A GR 5
AREA 30 FT	0 925	13 195	18.750
CY PER STA	31 209	48 870	69 444
TONS PER STA	* 62 692	* 91 631	111 111
TONS PER MILE	* 331001	* 9.030 1	5.866 7

* INCL WEIGHT OF BITUM MATL
+ TO BE APPLIED BETWEEN LIFTS OF PL MIX BITUM SURF BETWEEN PL MIX BITUM SURF & PL MIX BITUM BASE

BITUM. MATL.

	PL MIX BITUM SURF TYPE 3	PL MIX BITUM BASE	PRIME	TACK +
SQ YDS PER STA	375 000	403 333	399 999	388 888
TONS PER STA	4 081	4 388	0 303	
TONS PER MILE	215.5	231 8	26 6	
GALS PER STA				38 888
GALS PER MILE				2054 6

@ - FILL WITH A-2-4(0) MATERIAL

FAP F-235(W) 15 119

TO BE REMOVED BY RD. CONTRACTOR.
STA 434+50+200±28' CONC BEAM BRIDGE IN PTN
STA 446+33+-30 0'±25' PILE BRIDGE IN PTN

REMOVED & RESET BY STATE FORCES
STA 453+58 - USC&GS BRASS CAP #2177-1961 49'RT

REMOVED BY STATE FORCES
STA 454+70 DANGEROUS APP SIGN 29'LT
STA 458+83 MILE MARKER #63 8'RT

420 430 440 450 460 470 480

T 14 N - R. 15 E

439+50± - RD. CONTRACTOR TO CONSTRUCT & MAINTAIN DETOUR RT. - LUMP SUM BID. SEE SPEC PROVS

465+28± - RD. CONTRACTOR TO CONSTRUCT & MAINTAIN DETOUR RT. - LUMP SUM BID. SEE SPEC PROV.

S.66° 23' E.

PT STA 426+90 BK
EQUA: -75' PROV
= STA 426+97 AH

(UNDI) STA 448+32.2

STA 462+19 REA
LINE R.NO 8 19.5' CLEAR

(UNDI) STA 469+80

(UNDI) STA 471+30

DETOUR

INLET

RTW: EX. R/W

SEC 12

SEC

STA 423+25 NEW CULV 36"Ø CSP(16GA) INCL 1 SECT BEVEL END RT. 1 SEC CYLIND MITL 80 C.Y CULV EXC. 30 LIN. ENDS.

STA 427+00 RCB EXT 1 CELL 8'H 40'L

STA 431+60 15"X24" RCP IN APPLT REMOVE NEW 18"X12" PIPE 5 C.Y CULV EXC INCL 2 NEW FETS

STA 431+60 15"X24" RCP IN APPLT REMOVE NEW 18"X12" PIPE 5 C.Y CULV EXC INCL 2 NEW FETS

STA 441+35 15"X24" RCP IN 2 LT REMOVE 5 C.Y CULV EXC.

STA 443+00 NEW 60"Ø CMP RD APPR(16GA) 5 C.Y CULV EXC INCL 2 NEW FETS

STA 454+23 15"X24" CMP IN ADD RT REMOVE 5 C.Y CULV EXC.

STA 460+00 RD APPR RT REMOVE 5 C.Y CULV EXC. INCL 2 NEW FETS

STA 465+28 NEW 84"X53" SCORM (16GA) DRAIN 34 C.Y CULV EXC 90 C.Y RIPRAP MATL 2' THICK INCL CUTOFF WALLS INLET & OUTLET 3' @ INCL CONC APRT. INLET 1 OUTLET 7.0' @ CY CL '20 CONC

STA 471+81 18"X24" RCP IN INCL 2 RT REMOVE 5 C.Y CULV EXC

STA 473+00 NEW 18"X12" PIPE RD APPLT 5 C.Y CULV EXC INCL 2 NEW FETS.

STA 473+00 NEW 18"X12" PIPE RD APP RT. 5 C.Y CULV EXC INCL 2 NEW FETS

STA 473+25 15"X24" RCP IN PL RT REMOVE 5 C.Y CULV EXC.

STA 474+00 NEW 18"X12" PIPE RD APPR LT 5 C.Y CULV EXC INCL 2 NEW FETS

STA 476+36 CO RD APR LT 5 C.Y CULV EXC. INCL 2 NEW FETS

TYP. SEC NO. 6 — TRANS. TYP. 6 TO 2 — TYP. SEC NO. 2 — TRANS. TYP. 2 TO 6 — TYP. SEC NO. 6 — TYP. SEC. NO. 7 — TYP. SEC NO. 8 — TRANS. TYP. 7 TO 8

CMB: 711 B.C.Y. — TRANS. — EXC UNCL 58768 CY — HAUL 10648 MTL YDS.

STA 431+60 RD. APP LT & RT. 3 155 CY ADD. EXC.

INCL IN ROWY QUANT.

STA 443+00 RD. APPR LT & RT. 3 3535 C.Y ADD. EXC.

STA 460+00 RD. APP LT & RT. 3 200 CY ADD. EXC. INCL IN ROWY QUANT.

STA 465+28 INLET DT RT. 30 CY ADD. EXC.

STA 473+00 RD. APP LT & RT. 3 100 CY ADD. EXC. INCL IN ROWY QUANT.

STA 476+36 RD. RT APP LT. 3 100 CY ADD. EXC.

STA 423+50 TO STA 434+50 FILL DT. TO KEEP FROM WASHING - INCL IN ROWY QUANTS. (SEE X-SECTS)

CONC. APPR SLAB (STD. 8W8.34-M, 7 TYPE 'B')
STA. 433+40.5 TO 433+60.5 = 101.1 SQ. YDS.
STA. 435+19.5 TO 435+39.5 = 101.1 SQ. YDS.

112.5 LIN. FT. MET. GD. RAIL LT. & RT.

739+52± CK. CURB LT & RT. 240 CY ADD. EXC

433+60.5 B.C. 433 CY TYPE 'B' RANDOM RIP RAP - SEE SPEC PROVS.

435+19.5 B.C. 200 CY TYPE 'B' RANDOM RIPRAP - SEE SPEC PROVS.

1500' V.C.

Q 12400 E.F.S. R.W. 3865.1

2400 V.C.

DETOUR GRADE ELEV. 3868.0 +/-

+0.40% -1.77% +0.90%

DETOUR GRADE P.I. W. GRADE

EQUA 75' STA 426+903 BK = STA 426+978 AH

B.M. IRON PIN 30 RT STA 430+40 ELEV 3892.12

B.M. IRON PIN 5 RT STA 434+00 ELEV 3868.70

B.M. IRON PIN 30 RT STA 440+00 ELEV 3894.70

B.M. IRON PIN 36 LT STA 450+00 ELEV 3901.27

B.M. IRON PIN 41 LT STA 460+00 ELEV 3917.60

B.M. IRON PIN 42 LT STA 470+00 ELEV 3915.28

B.M. IRON PIN 41 RT STA 480+00 ELEV 3928.87

3940 30 20 10 3900 90 80 70 3860

420 5 430 5 440 5 450 5 460 5 470 5 480

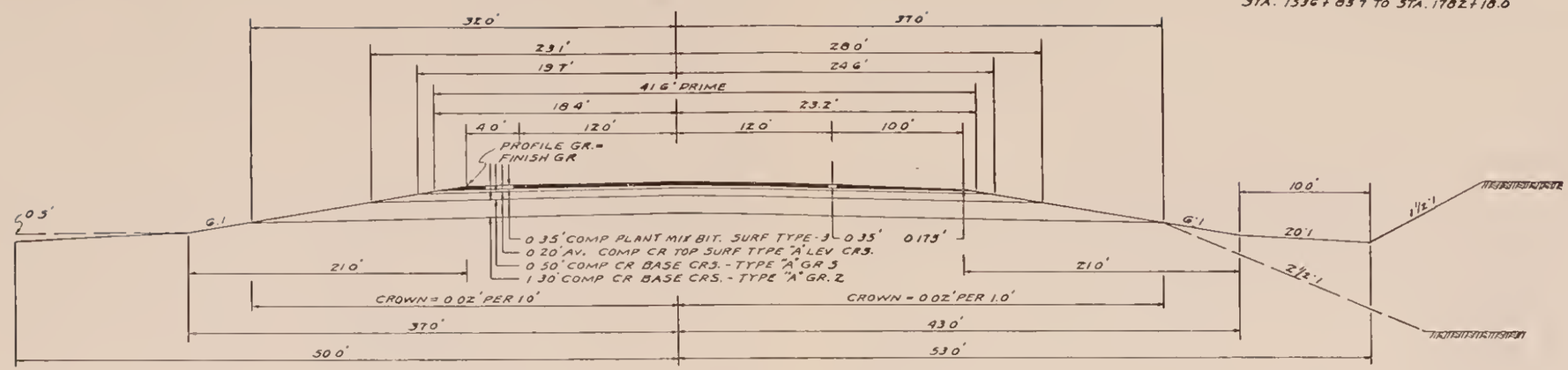
K-E

STATE	PROJECT NO	SHEET NO
MONTANA	I-IG 15-7(13) 323	7

TYPICAL SECTION NO. 1

MAINLINE

STA. 1303 + 36 3 TO STA. 1303 + 73 3
STA. 1336 + 03 7 TO STA. 1702 + 10.0



℄ MEDIAN 100' CENTERS

QUANTITIES								
GRAVEL					BITUMINOUS MAT'L.			
UNIT	PL MIX TYPE-3	CR TOP SURF LEVELING CRS.	CR BASE CRS. - TYPE "A" GRADE-5	CR BASE CRS. - TYPE "A" GRADE-2	UNIT	MIX	PRIME	TACK
AREA SQ FT	13.0	8 G	23 9	7 8 1	S Y. PER STA.	411 1	4G2 2	4G2 2
C.Y. PER STA.	48 1	31.9	88 5	289 3	TONS PER STA.	G 3	0 G	
TONS PER STA	*96 4	49 4	137 2	448 4	GALS PER STA			4G 2
TONS PER MI	*5089 9	2608 3	7244 2	23G755	TONS PER MI	332 G	31.7	
					GALS PER MI.			24394

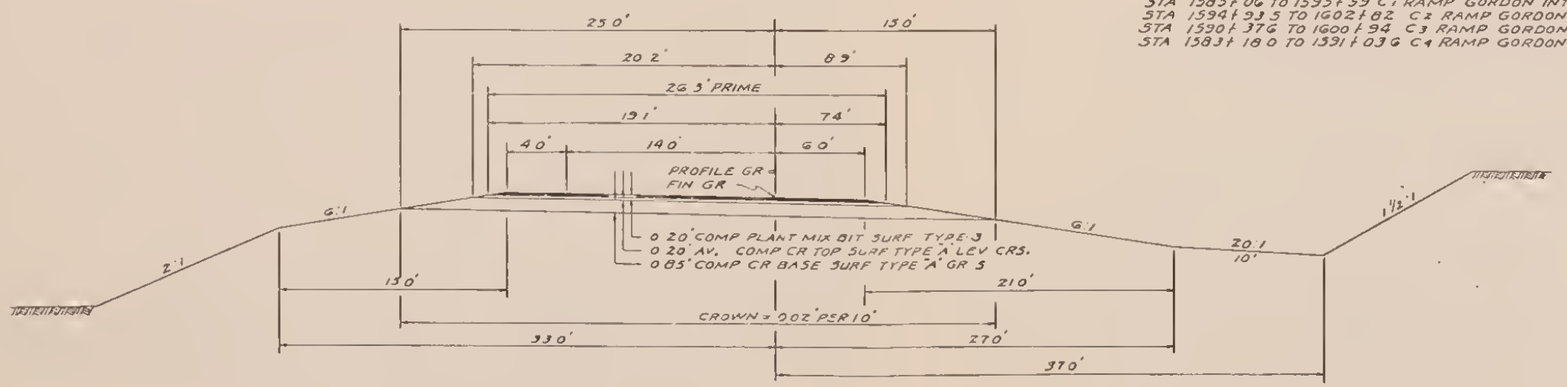
*INCLUDES WEIGHT OF PLANT MIX OIL

STA 1426 TO 1432 1½:1 LT & RT
STA 1543 TO 1547 1:1 LT.

TYPICAL SECTION NO. 2

RAMP

STA 1583 + 06 TO 1595 + 59 C1 RAMP GORDON INTERCHANGE
STA 1594 + 93 5 TO 1602 + 82 C2 RAMP GORDON INTERCHANGE
STA 1590 + 37G TO 1600 + 94 C3 RAMP GORDON INTERCHANGE
STA 1583 + 18 0 TO 1591 + 03 G C4 RAMP GORDON INTERCHANGE



QUANTITIES								
GRAVEL					BITUMINOUS MAT'L.			
UNIT	PL MIX TYPE-3	CR TOP SURF LEVELING CRS.	CR BASE CRS. - "TYPE "A" GRADE-5	CR BASE CRS. - "TYPE "A" GRADE-2	UNIT	MIX	PRIME	TACK
AREA 30 FT	51	56	294		S.Y. PER STA.	280 6	2949	2944
C Y PER STA.	189	207	1089		TONS PER STA	24	04	
TONS PER STA	*376	321	1688		GALS PER STA			294
TONS PER MI	9853	1694 9	8912 6		TONS PER MI	126 7	21 1	
					GALS PER MI			15523

*INCLUDES WEIGHT OF PLANT MIX OIL

STATE	PROJECT NO.	SHEET NO.
MONTANA	F-155(9)	16

860
860+00
18" C.S.P. REMOVE
NEW 18" PIPE

CENTER SECTION
599.0' CT.

CENTER SECTION
606.3' LT.

STOCKPILE

BOWLING ALLEY

870

T. 29 N. R. 35 E.

872+75
15" C.S.P. REMOVE
NEW 18" PIPE

874+45
12" C.S.P. REMOVE
NEW 18" PIPE

876+06
15" C.S.P. REMOVE
NEW 18" PIPE

877+01
15" C.S.P. REMOVE
NEW 18" PIPE

880

890

STA 887+96
PWR LINE X-ING
2-WIRES 222' CL.

PI STA 887+30

IRR. DT.

R/W

SIGN

SIGNS

MH

NO.

GAR.

ROCK WALL

N 45°30' E.

RIPRAP

HAY CORRAL

CONC HG

IRR. DT.

+25
70'

+50
90'

+40
90'

MET. BLDG

QUONSET

HG

SIGN

+00
70'

+00
30'

Δ = 2°18' RT.
D = 0°30'
T = 230.0'
L = 460.0'
R = 11,460.0'

PC STA 885+10.50

+50 BEG. CONST. PERMIT

CONC EDGE PROT

+50 END CONST. PERMIT

HAY CREEK

886+00
20 YDS. BR-REMOVE
NEW 120 S.Y. P.C.
BEDDING MAT'L.
CONC. EDGE PROT.
TYPE 8 RANDOM RIPRAP
CONC. CUT-OFF WALLS

EQ-22' PT STA 889+30 BK =
PT STA 888+67.2 AH

889+00
24" C.S.P. REMOVE
NEW 24" PIPE

860+00
30" C.S.P. REMOVE
NEW 36" PIPE

860+83
18" C.S.P. REMOVE
NEW 18" PIPE

863+50
18" C.S.P. REMOVE
NEW 24" C.S.P. (SYP.)

861+00
RD. APP. LT. & RT.

874+23
DBL. RD. APP. RT.

878+75
RD. APP. RT.

DESIGN FREQUENCY =
DESIGN FLOW =
HIGH WATER ELEVATION =

EQUATION
889+66 =
889+67

+0.39%

-0.05%

400' V.C.

PI. 870+35 = 2105.00

2110
2100
2090

860 865 870 875 880 885 890

STANDARD DRAWINGS

Evaluations of standard drawings were accomplished in a sheet-by-sheet content analysis and by a survey of users.

The objectives of this work were:

1. To review and evaluate existing standard drawings, the ways in which they are used and the extent of their usage.

2. To define general policies with regard to the purposes of standard drawings and the most appropriate ways in which they should be compiled and distributed.

3. To develop an outline list of needed standard drawings and to establish general content and format.

4. To define responsibilities, procedures and schedule for standards development and transition to new practices.

5. To develop improved standard drawings.

CATEGORIES OF STANDARD DRAWINGS

The analyses of the standard drawings resulted in the identification of six purposes for which the drawings were used. They are:

1. Drawings which provide complete details of construction items.

2. Drawings which provide miscellaneous construction details but which must be supplemented with additional design and plan preparation.

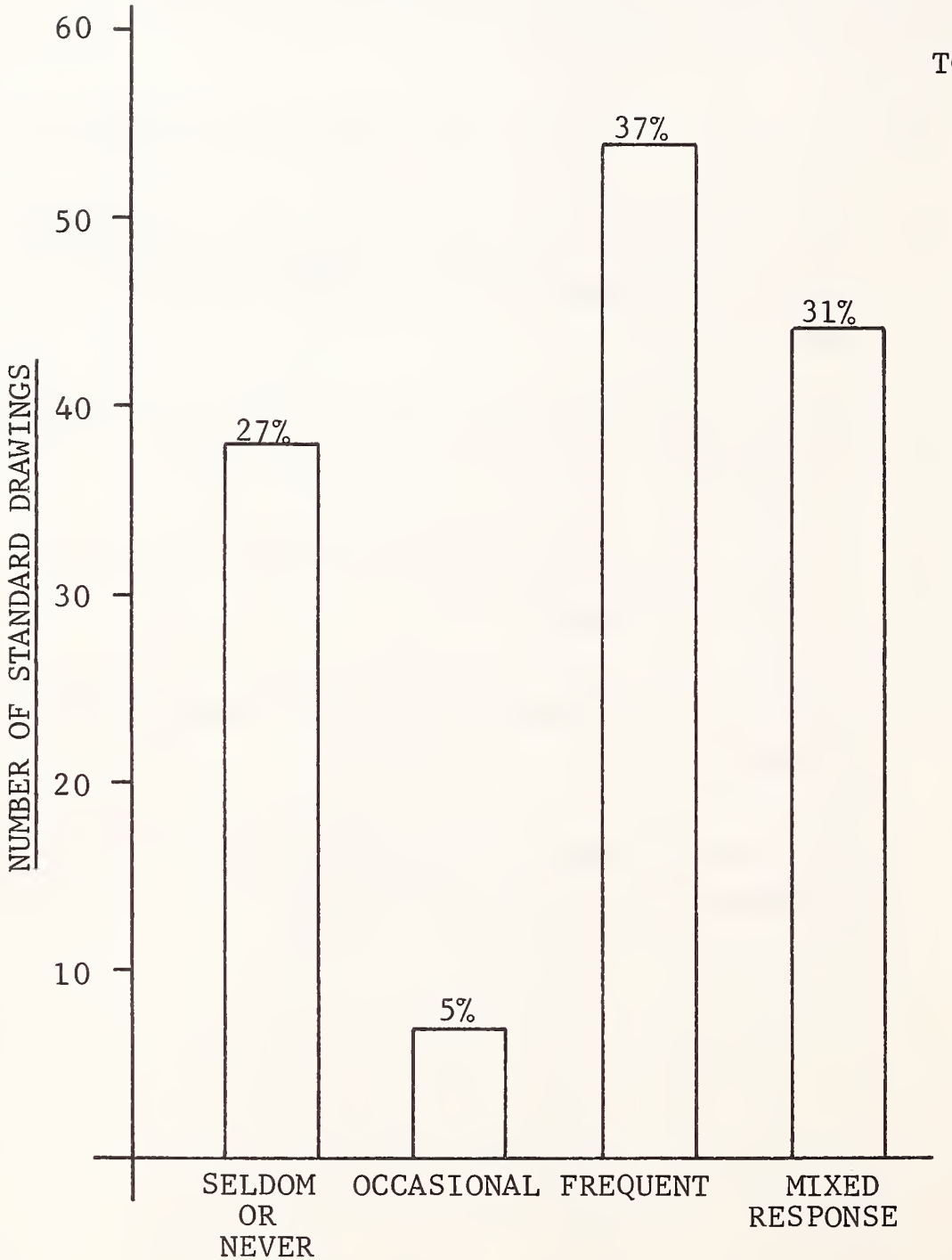
3. Drawings which describe materials and supplies to be incorporated in the work.

4. Drawings which illustrate typical installations--used principally as guides by designers.

5. Drawings which document design criteria--used principally by designers.

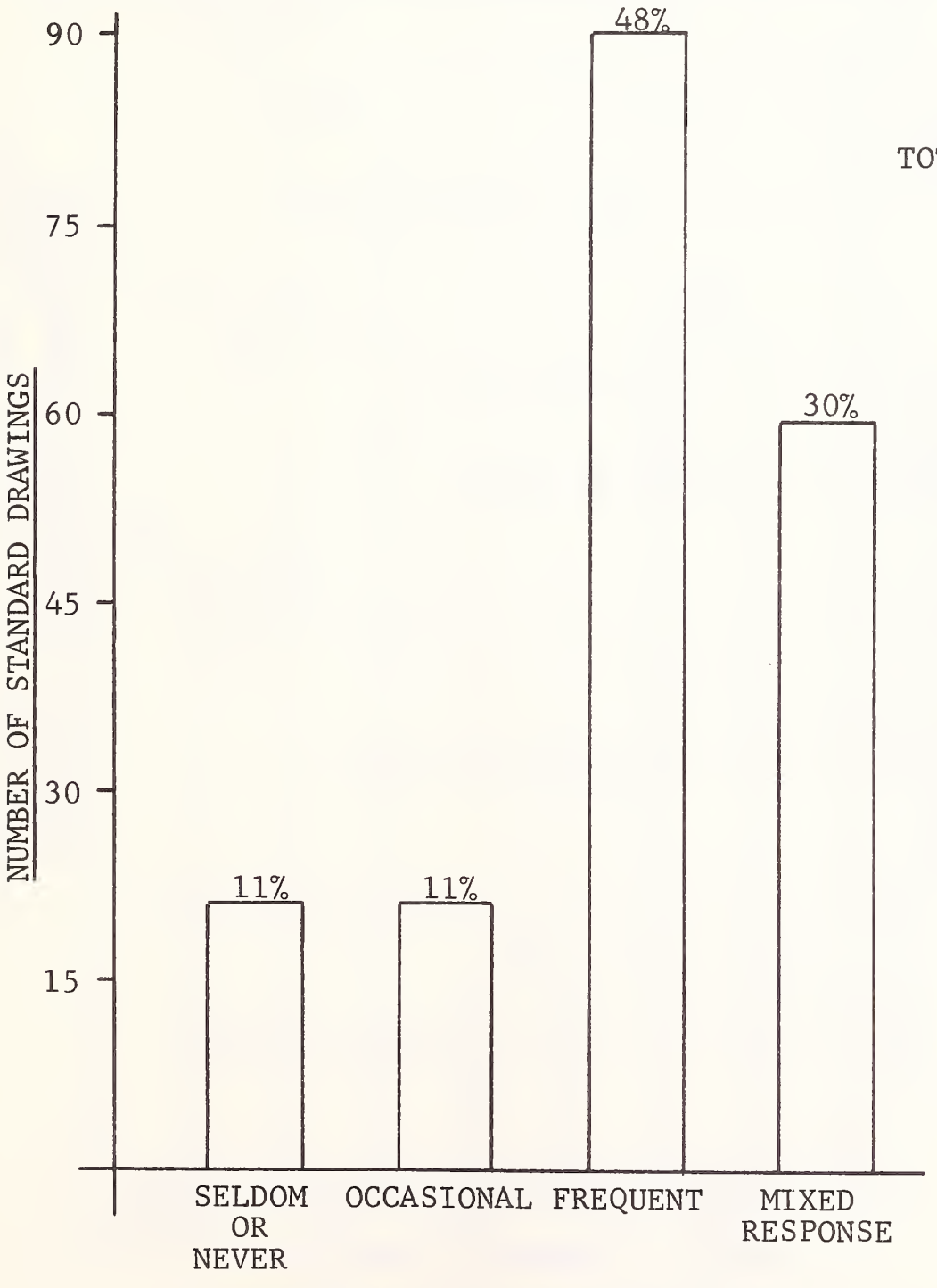
6. Drawings which supplement the standard specifications, providing additional explanation and clarification.

STANDARD DRAWING ANALYSIS
FREQUENCY OF USAGE ESTIMATES
DESIGNERS



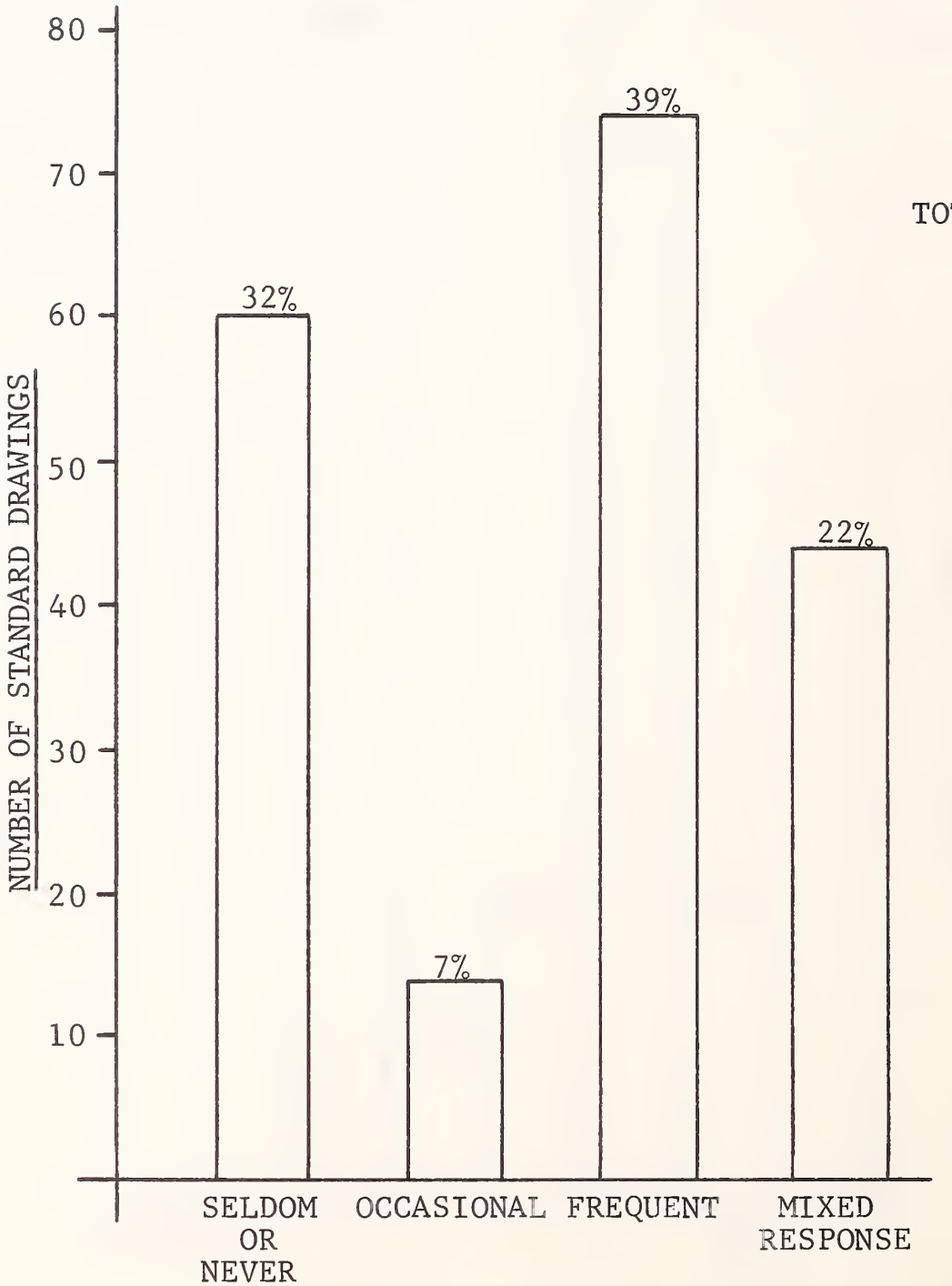
*Additional analysis required on 46 traffic control device standard drawings

STANDARD DRAWING ANALYSIS
FREQUENCY OF USAGE ESTIMATES
CONTRACTORS AND PROJECT PERSONNEL



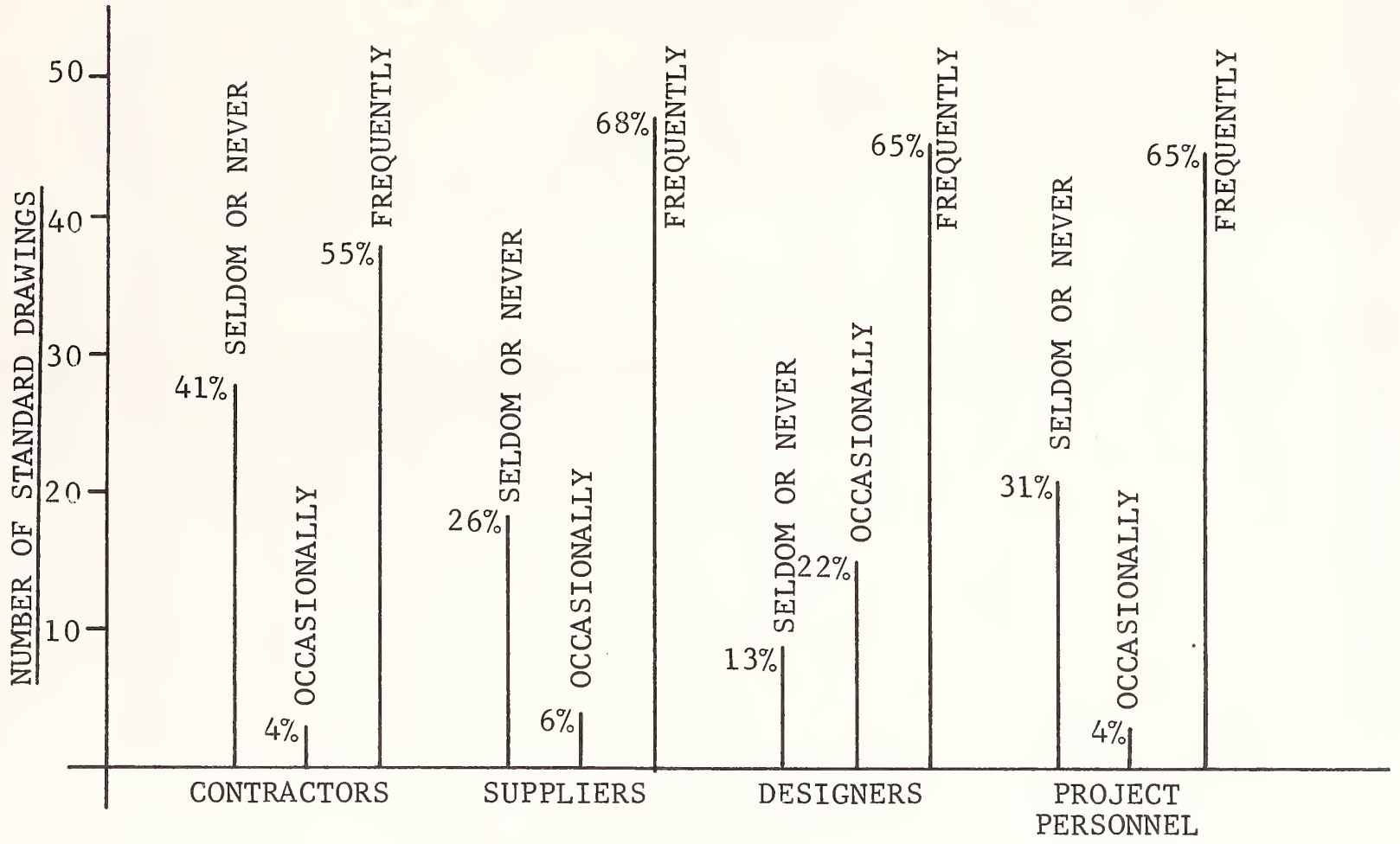
TOTAL 189

STANDARD DRAWING ANALYSIS
FREQUENCY OF USAGE ESTIMATES
SUPPLIERS



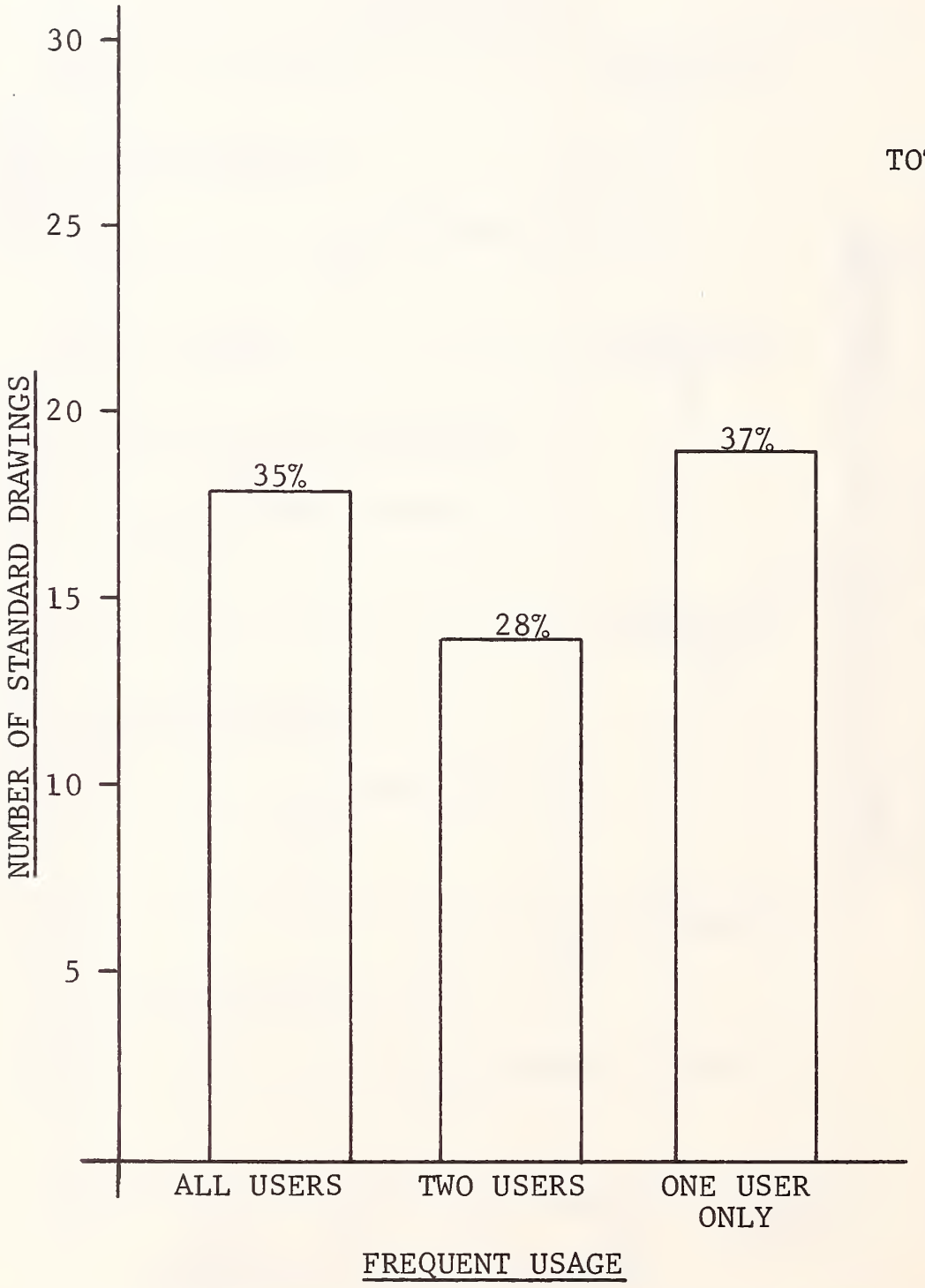
TOTAL 189

STANDARD DRAWING ANALYSIS
FREQUENCY OF USAGE ESTIMATES
TRAFFIC STANDARD DRAWINGS



TYPES OF USERS

STANDARD DRAWING ANALYSIS
COINCIDENCE OF FREQUENT USAGE



*Excludes analysis of 68 traffic control device standard drawings

STANDARD DRAWINGS ANALYSIS
ROAD DESIGN

PRESENT

199 Effective Standard Drawings

109 Revisions (Last $1\frac{1}{2}$ Years)

28 Deletions

All personnel and contractors must have knowledge of 336 standards

PROPOSED

Category	Total Existing Sheets	Plans Sheets
Standard Drawings	103	40-50
Standard Sheets	41	0
Special Provisions	2	0
Sign Manual	27	0
Deletions	26	
	199	

EXAMPLE OF SHEET-BY-SHEET STANDARD DISPOSITION

STANDARD NUMBER	NAME OF STANDARD	STANDARD DRAWING	STANDARD SHEET	OTHER
41-01	Box Culvert Data - Reference			Delete
41-05	Box Culvert Data-- Reference			Delete
50-01	Culvert Riprap	x		
50-02	Grouted Riprap			Delete
50-03	Riprap Quantities		x	
50-04	Embankment Protection	x		
50-05	Concrete Drainage Chute	x		
50-20(A)	Concrete Slope Protection			Delete
50-20(B)	Concrete Slope Protection			Delete
50-20(C)	Concrete Slope Protection			Delete
50-21(A)	Concrete Slope Protection - Alternate II	x		
50-21(B)	Concrete Slope Protection - Alternate II	x		
51-01	Metal Bin - Type Retaining Wall	x	Seldom Used	
51-02	Concrete Crib Retaining Wall			Delete
51-03	Backfill Retainer and Cutoff Wall for Vehicular Underpass	x		

POLICY

STANDARD DRAWINGS AND STANDARD SHEETS--
DEVELOPMENT AND UTILIZATION

Date Issued

POLICY: Standard Drawings will be developed and utilized to illustrate details of construction and materials which are uniformly incorporated in the design of construction projects.

The Department of Highways will utilize Standard Drawings only for those work items and materials which:

1. Occur frequently enough thoughout the year to warrant a master detail in order to reduce the considerable amounts of detailing and drafting effort required if drawn individually for each project, and

2. Can be defined and illustrated in ways clearly understandable for uniform application on all projects.

Standard Drawings for road construction, signing and lighting construction and bridge construction will be inserted in the detail section of the contract plans.

The Department of Highways will utilize Standard Sheets only for those details of construction and materials which serve principally as guides and criteria for project design. Standard Sheets will be utilized by Department personnel in the development of contract plan design and will not be distributed to contractors or material suppliers except as individual details in the contract plans.

Uniform title blocks will be established clearly identifying the sheet as a Standard Drawing or Standard Sheet, with provisions for signatures and revision dates.

POLICY

STANDARD DRAWINGS AND STANDARD SHEETS--
DEVELOPMENT AND UTILIZATION

Date Issued

The content and format of all Standard Drawings and Standard Sheets utilized by Department personnel will be reviewed annually to ensure conformance with this policy.

SCOPE: This policy applies to all design projects let after January 1, 1972 and will be implemented as feasible on projects let prior to that date.

This statement of policy is made in order to assure consistency in design and construction and minimize detailing and drafting work effort for individual projects.

RESPONSIBILITY: The State Highway Engineer will ensure that all Standard Drawings and Standard Sheets utilized by the Department are consistent with good engineering practices and Montana statutory requirements. He will approve all Standard Drawings and Standard Sheets and subsequent revisions thereto.

The Chief, Bureau of Road Design will ensure that all Standard Drawings and Standard Sheets related to road construction and signing and lighting construction are developed, revised and distributed according to the guidelines of this policy. He will review annually the content of all Standard Drawings and Standard Sheets for which he is responsible.

The Chief, Bureau of Bridge Design will ensure that all Standard Drawings related to bridge construction are developed, revised and distributed according to the guidelines of this policy. He will review annually the content of all Standard Drawings for which he is responsible.

PROCEDURE

STANDARD DRAWINGS AND STANDARD SHEETS--
DEVELOPMENT AND UTILIZATION

Date Issued

AUTHORITY: This procedure has been prepared by the Chief, Bureau of Road Design and approved by the State Highway Engineer in accordance with the Department policy on Standard Drawings and Standard Sheets -- Development and Utilization.

PURPOSE: To establish the procedure for the development, review, approval and revision of Standard Drawings and Standard Sheets utilized by the Montana Department of Highways.

PROCEDURE:

Responsibility		Action
Section Heads	1.	Determine the need for a standard which meets one of the following:
		a. Standard Drawing -- The subject matter (1) occurs frequently enough throughout the year to warrant a master detail in order to reduce the considerable amounts of detailing and drafting effort required if drawn individually for each project, and (2) can be defined and illustrated in ways clearly understandable for uniform application on all projects.
		b. Standard Sheet -- The subject matter serves principally as guides and criteria for project design.
	2.	Determine that the need does not meet the above criteria and that it is preferable to incorporate specific details in the plans for individual projects.
	3.	Prepare a preliminary definition of the scope of the standard including, but not limited to the following:
		a. A statement of the objective to be realized. b. A rough sketch of the proposed standard. c. A definition of specific problems to be resolved.

PROCEDURE

STANDARD DRAWINGS AND STANDARD SHEETS -- DEVELOPMENT AND UTILIZATION

Date Issued

Responsibility		Action
Section Heads	4.	Insure that the proposed standard is adequate according to good engineering practice and meets the Federal Highway Administrations requirements and Montana legal requirements.
	5.	Transmit the preliminary data to the Supervisor, Location and Road Design and requests the development of the standard.
Supervisor, Location and Road Design	6.	Reviews the recommendation and preliminary information.
	7.	Determines the priority for the development of the standard.
	8.	Assigns the further development to Standards Specialist.
Standards Specialist	9.	Determines the need for specialized data such as hydraulics, traffic, materials, bridge or construction information
	10.	Develops a schedule for the development of the standard.
	11.	Requests the specialized data or special studies from the appropriate source.
	12.	Receives the required information to develop the standard.
	13.	Completes the development of the standard in pencil.
	14.	Furnishes the preliminary standard to the Locations and Road Design Supervisor.
Supervisor, Location and Road Design	15.	Reviews the preliminary standard for adequacy.
	16.	Transmits the standard to the Chief, Bureau of Road Design.
Chief Bureau of Road Design	17.	Reviews the standard and obtains the approval of the standard content from the Administrator of Engineering.

PROCEDURE

STANDARD DRAWINGS AND STANDARD SHEETS--
DEVELOPMENT AND UTILIZATION

Date Issued

Responsibility		Action
Chief Bureau of Road Design	18.	Transmits the standard to the Federal Highway Administration and requests approval.
	19.	Receives approval of the Standard from the Federal Highway Administration.
	20.	Approves completion of Standard by Locations and Road Design Supervisor for distribution as follows:
		a. Standard Drawing -- distributed (1) to all recipients of the Field and Office Standards and the Design Manual for reference purposes, and (2) to contractors, suppliers and department personnel attached as a part of the contract plans for which the Standard Drawing applies.
		b. Standard Sheet -- distributed to all recipients of the Field and Office Standards and the Design Manual for reference purposes.
Standards Specialist	21.	Accomplishes the distribution accordaing to the above criteria.
Chief Bureau of Road Design	22.	Requests reviews and report annually from Section Heads, as well as the Construction Engineer and District Engineers to ascertain the adequacy and accuracy of the Standards.
	23.	Requests the Supervisor, Location and Road Design to modify the existing Standards as needed.
Supervisor, Location and Road Design	24.	Completes the modification of the standards as requested.

Requests from other divisions should be directed to the Chief, Bureau of Road Design for his action. Requests should be accompanied by (1) a statement of the objective to be realized, (2) a rough sketch of the proposal, (3) a definition of specific problems to be resolved.

STANDARD DRAWING INDEX

Standard Drawing Title and Section Heading	Reference Number To Standard Specifications Sections	Drawing Number
CONSTRUCTION SIGNING		
1. Construction Sign CS5R	7	1
2. Construction Signs CIS - 1 and CIS - 2	7	2
3. Construction Signing Standards	none	3, 4 & 5
4. Construction Signing Standards-- Side Approach, Lane Closing and Windrow Signing	none	6
5. Construction Signing Standards -- Erection and Sign Details	none	7
6. Construction Signing Standards -- Barricades	none	8
PORTLAND CEMENT CONCRETE PAVEMENT		
1. 8" P.C. Concrete Pavement -- Sawed Joints with Tie Bars	39	15
2. 8" P.C. Concrete Pavement -- Expansion Joints and Dowel Sleeves	39	16
3. 8" P.C. Concrete Pavement -- Sawed and Keyway Joints	39	17
4. Standard Concrete Approach Slab to Structures	39	18
5. Standard Concrete Approach Slab to Structures with U-Type Abutments	39	19

Standard Drawing Title and Section Heading	Reference Number To Standard Specifications Sections	Drawing Number
SLOPE AND BANK PROTECTION, AND CULVERT END TREATMENTS		
1. Culvert Riprap	50	25
2. Embankment Protection	50	26
3. Concrete Slope Protection	50	27
4. Concrete Drainage Chute	50	28
5. Embankment Protector	56	29
6. Cutoff Walls for Culverts	73	30
7. Concrete Edge Protection for Structural Plate Pipe Culvert and for Structural Plate Pipe-Arch Culvert	73	31
8. Concrete Edge Protection for Concrete Culverts	73	32
9. Backfill Retainer and Cutoff Wall for Vehicular Underpass	51	33
10. Inlet and Outlet Headwalls for R.C.P. and C.M.P. Pipes	73	34
CULVERTS AND RELATED ITEMS		
1. C.S.P. and S.S.P.P. Culvert Bedding	54	40
2. R.C.P. Culvert Bedding	54	41
3. Semicircular Underdrain	69	42
4. Filter Material for Underdrains	54	43
5. Step Bevel for Circular C.S.P. and S.S.P.	59	44

STANDARD DRAWING INDEX

Standard Drawing Title and Section Heading	Reference Number To Standard Specifications Sections	Drawing Number
CULVERTS AND RELATED ITEMS (continued)		
6. Bevel on Structural Plate Pipe Arch	59	45
7. Flared End Terminal Section -- Corrugated Metal Pipe	56 and 57	46
8. Prefabricated Terminal Section for Reinforced Concrete Pipe	62	47
9. Prefabricated R.C.P. Arch Culvert and Terminal Section	63	48
10. Typical Field Cast Concrete Bend R.C.P. to C.M.P. Connection	54	49
11. Structural Plate Pipe Stockpass	59	50
12. Vehicular Underpass	59	51
13. Standard Irrigation Division Box	73	52
14. Drop Inlet Boxes and Cover	77	53
15. Curb Inlet Box and Cover	77	54
16. Median Inlet Cover	77	55
17. Combination Manhole and Catch Basin	77	56
18. Precast Concrete Manhole	77	57
CURBS AND SIDEWALK		
1. Concrete Sidewalk	75	65
2. Standard Curbs	76	66
3. Concrete Median Curbs	75	67
4. Precast Traffic Curbs	75	68

Standard Drawing Title and Section Heading	Reference Number To Standard Specifications Sections	Drawing Number
FENCE AND CATTLE GUARD		
1. Wire Fence - Interstate Type	81	75
2. Chain Link Fence	80	76
3. Median Barrier Fence	80	77
4. Farm Fence	81	78
5. Cattle Guard	82	79
GUARD RAIL		
1. Metal Guard and Median Rail	90	85
2. Bridge End Treatment	90	86
3. Pier Treatment	90	87
4. Guardrail for Grade Crossing Protection	90	88
5. Guardrail Terminal Sections	90	89
6. Cable Guard Rail	90	90
7. Cable Guard Rail Driveway Anchor Section	90	91
MISCELLANEOUS STANDARDS		
1. Slope Rounding	11	100
2. Roadway Embankment at Bridge End	11	101
3. U-Turn Median Openings on Controlled Access Highways	11	102
4. Approaches	20	103
5. Monuments and Markers	96	104

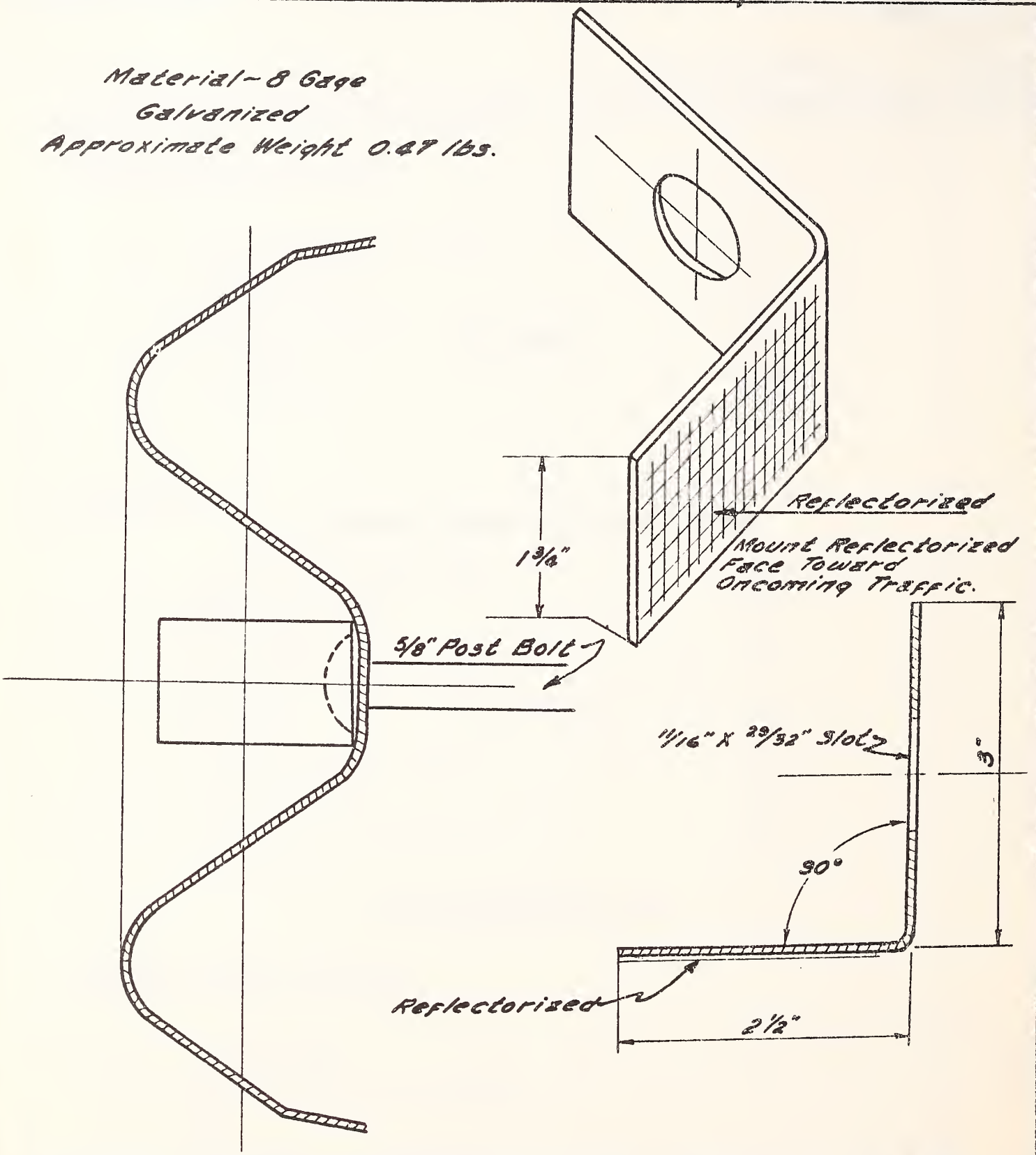
EXAMPLE OF

THREE EXISTING STANDARD DRAWINGS

REDUCED TO

ONE STANDARD DRAWING

DRAWN 9-5-69	REVISED EFFECTIVE 7-1-70	STANDARD DRAWING 90-17
STATE HIGHWAY COMMISSION HELENA, MONTANA	**REFLECTOR - WASHER**	APPROVED [signature] 9/5/69 STATE HIGHWAY ENGINEER



All sections of guard rail shall have reflector-washers installed every 25 ft. except for the turned down anchor and departure sections. Reflector-washers are not required on bridge end, bridge pier or grade crossing protection guard rail.

The use of reflectors will replace the need for the rectangular washers required to fasten rail to post.

Reflector-washers to be included in the unit price per linear foot of guard rail.

REVISED	11-1-70	
EFFECTIVE	1-1-71	

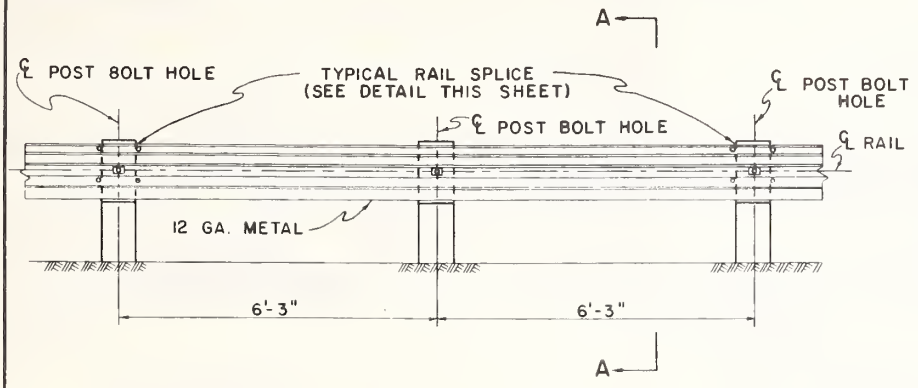
STANDARD DRAWING NO. 90-03

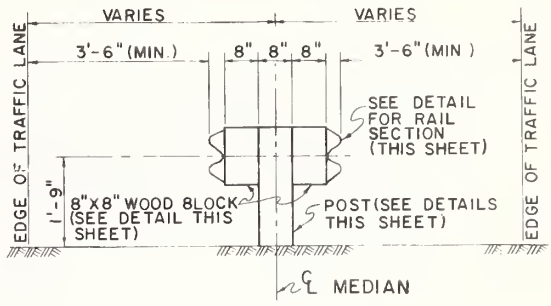
STATE HIGHWAY COMMISSION
HELENA, MONTANA

METAL MEDIAN RAIL

APPROVED

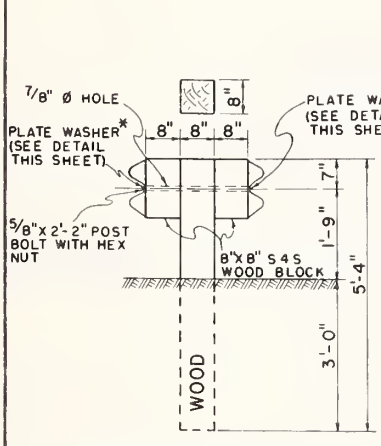
STATE HIGHWAY ENGINEER



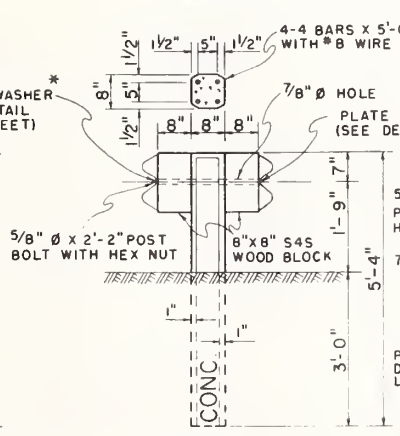


SECTION A-A

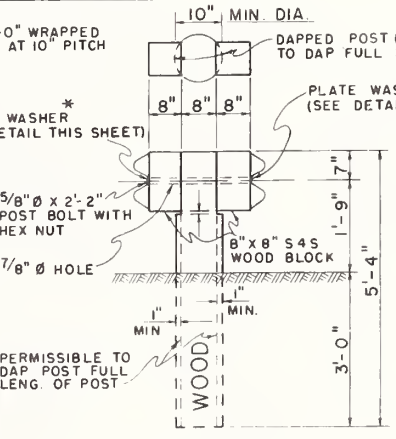
METAL BEAM MEDIAN RAIL



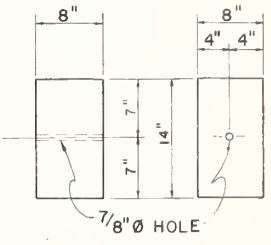
SQUARE WOOD POST



CONCRETE POST



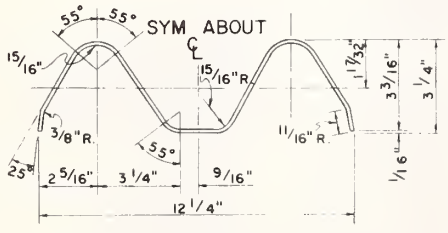
ROUND WOOD POST



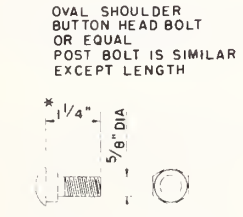
WOOD BLOCK DETAIL

* USE REFLECTOR WASHERS IN PLACE OF PLATE WASHER AS NOTED ON STANDARD DRWG. 90-08.

DETAIL OF GUARD RAIL POSTS

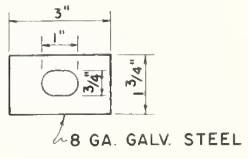


RAIL SECTION



* POST BOLT LENG = 2'-2"

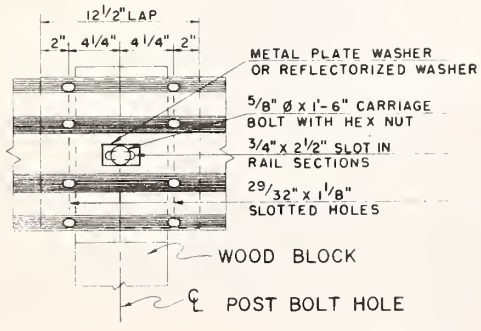
SPLICE BOLT & NUT



8 GA. GALV. STEEL

WASHER TO BE PLACED BETWEEN HEAD AND RAIL OF POST BOLT. USE ON POST CONNECTIONS THAT DO NOT USE REFLECTOR WASHER. USE ON BOTH SIDES OF MEDIAN RAIL.

PLATE WASHER DETAIL


12½" LAP
2" 4¼" 4¼" 2"
METAL PLATE WASHER OR REFLECTORIZED WASHER
5/8" Ø x 1'-6" CARRIAGE BOLT WITH HEX NUT
¾" x 2½" SLOT IN RAIL SECTIONS
29/32" x 1⅛" SLOTTED HOLES
WOOD BLOCK
℄ POST BOLT HOLE

RAIL SPLICE DETAIL
(LAP IN DIRECTION OF TRAFFIC)

RAIL: GALVANIZED RAIL SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A 93 OR ASTM A 123. STEEL RAIL SHALL CONFORM TO AASHO M 180. ALL RAIL PLATES ARE TO BE LAPPED IN DIRECTION OF TRAFFIC.

POSTS: ROUND POSTS SHALL HAVE NO DIAMETER LESS THAN 10" ONLY ONE TYPE POST (SQUARE OR ROUND) TO BE USED WITHIN ONE PROJECT.

TERMINAL SECTIONS: SEE STD. DWG. NO. 90-05, 90-06 AND NO. 90-07 FOR APPROACH AND DEPARTURE TERMINAL SECTIONS.

BRIDGE APPROACH: SEE STD. DWG. NO. 90-04 FOR TREATMENT AT BRIDGE ENDS.

REFLECTOR WASHER: ALL SECTIONS OF GUARDRAIL SHALL HAVE REFLECTOR-WASHERS SPACED EVERY 25 FT. SEE STD. DWG. NO. 90-08 FOR DETAILS.

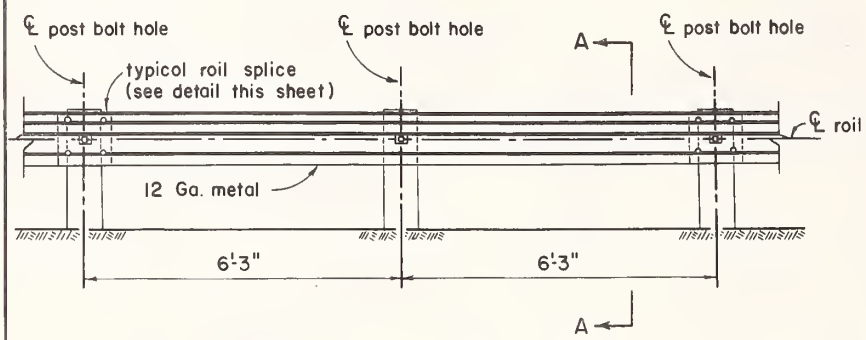
REVISED	4-15-68	11-22-68	4-4-69	11-1-70
EFFECTIVE	11-1-68	1-1-69	7-1-69	1-1-71

STANDARD DRAWING NO. 90-02

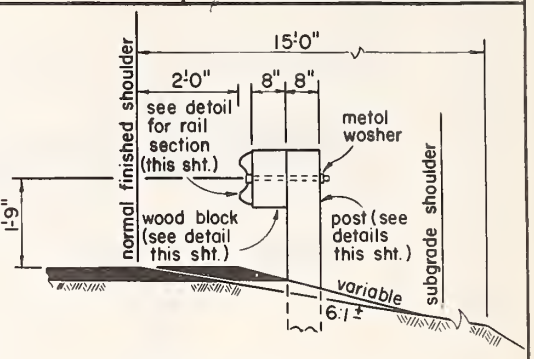
STATE HIGHWAY COMMISSION
HELENA, MONTANA

METAL GUARD RAIL

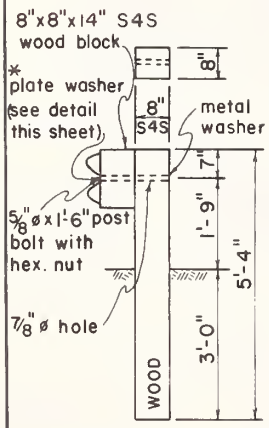
APPROVED
STATE HIGHWAY ENGINEER



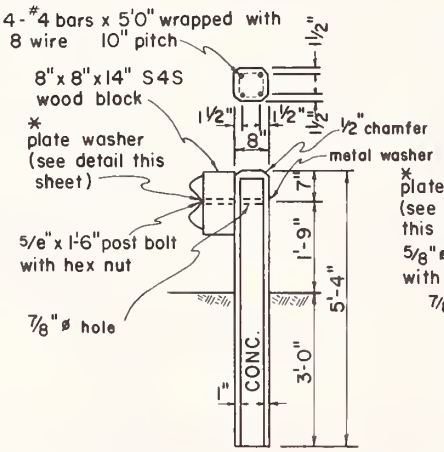
METAL GUARD RAIL



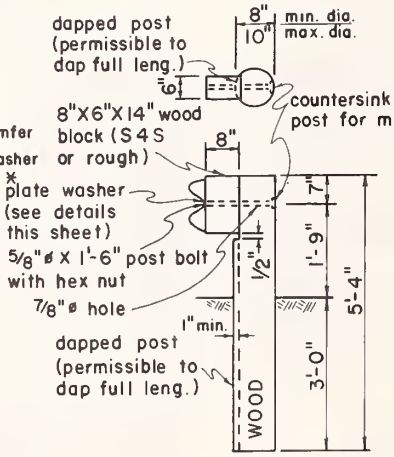
SECTION A-A



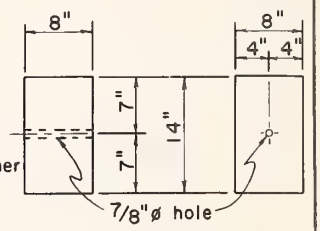
SQUARE WOOD POST



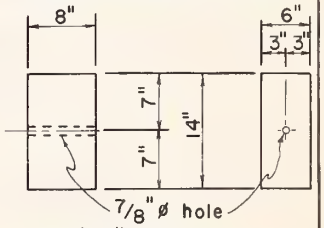
CONCRETE POST



ROUND WOOD POST



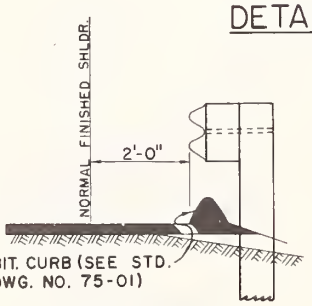
8"X8"X14" WOOD BLOCK
(FOR SQUARE POSTS)



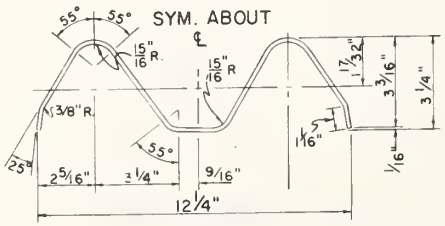
8"X6"X14" WOOD BLOCK
(FOR ROUND POSTS)

* USE REFLECTOR WASHERS IN PLACE OF PLATE WASHERS AS NOTED ON STD. DWG. 90-08.

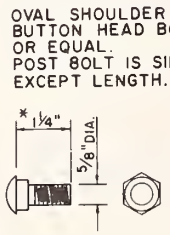
DETAIL OF GUARD RAIL POSTS



BITUM. CURB WITH GUARD RAIL

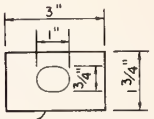


RAIL SECTION



*POST BOLT LENG. = 1'-6"

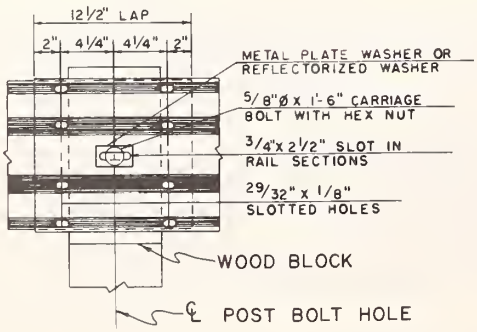
SPLICE BOLT & NUT



8 GA. GALV. STEEL

WASHER TO BE PLACED BETWEEN HEAD AND RAIL OF POST BOLT. USE ON POST CONNECTIONS THAT DO NOT USE REFLECTORS.

PLATE WASHER DETAIL



RAIL SPLICE DETAIL
(LAP IN DIRECTION OF TRAFFIC)

NOTES

RAIL: GALVANIZED RAIL SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A 93 OR ASTM A 123. STEEL RAIL SHALL CONFORM TO ASSHO M 180. ALL RAIL PLATES ARE TO BE LAPPED IN DIRECTION OF TRAFFIC.

POSTS: ROUND POSTS SHALL HAVE NO DIAMETER LESS THAN 8" OR MORE THAN 10", ONLY ONE TYPE POST (SQUARE OR ROUND) TO BE USED WITHIN ONE PROJECT.

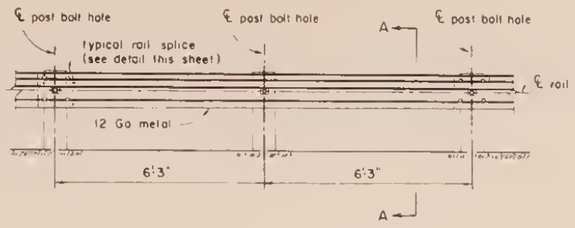
TERMINAL SECTIONS: SEE STANDARD DRAWING NO. 90-05, NO. 90-06 AND NO. 90-07 FOR APPROACH AND DEPARTURE TERMINAL SECTIONS.

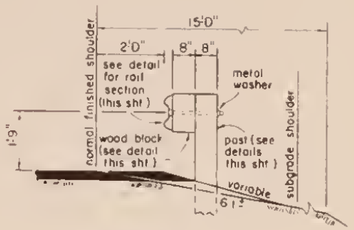
BRIDGE APPROACH: SEE STANDARD DRAWING NO. 90-04 FOR TREATMENT AT BRIDGE ENDS.

REFLECTOR-WASHER: ALL SECTIONS OF GUARD RAIL SHALL HAVE REFLECTOR WASHERS SPACED EVERY 25 FT. SEE STANDARD DRAWING NO. 90-08 FOR DETAILS.

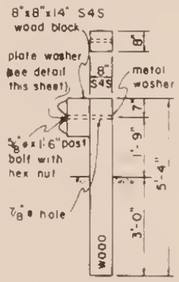
STATE	PROJECT NO	SHEET NO
MONTANA		

METAL GUARD RAIL

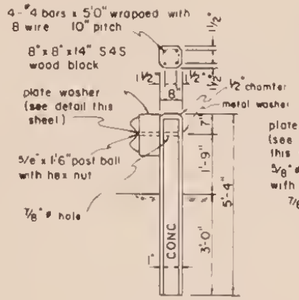




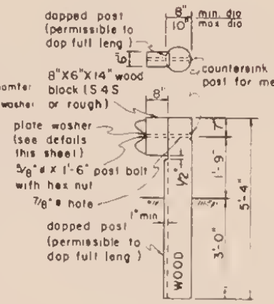
SECTION A-A



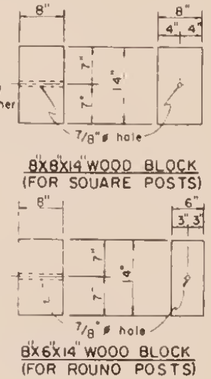
SQUARE WOOD POST



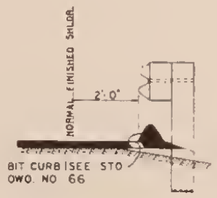
CONCRETE POST



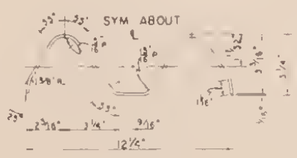
ROUND WOOD POST



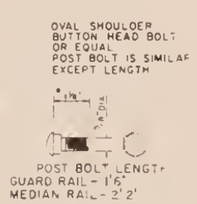
DETAIL OF GUARD RAIL POSTS



BITUM CURB WITH GUARD RAIL

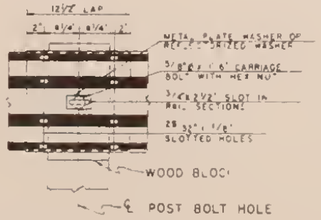


RAIL SECTION



SPLICE BOLT & NUT

PLATE WASHER DETAIL


12 1/2" LAP
2" 3 1/4" 3 1/4" 2"
METAL PLATE WASHER OR REFLECTORIZED WASHER
5/8"ø x 1'-0" CARRIAGE BOLT WITH HEX NUT
3/4"ø x 2 1/2" SLOT IN RAIL SECTION
2@ 3 1/2" x 1 1/2" SLOTTED HOLES
WOOD BLOCK
℄ POST BOLT HOLE

RAIL SPLICE DETAIL
LAP IN DIRECTION OF TRAFFIC

NOTES

RAIL GALVANIZED RAIL SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A 93 OR ASTM A 123. STEEL RAIL SHALL CONFORM TO ASSHO M 180. ALL RAIL PLATES ARE TO BE LAPPED IN DIRECTION OF TRAFFIC.

POSTS ROUND POSTS SHALL HAVE NO DIAMETER LESS THAN 8" OR MORE THAN 10" ONLY ONE TYPE POST (SQUARE OR ROUND) TO BE USED WITHIN ONE PROJECT.

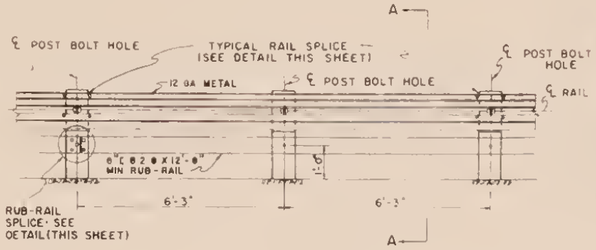
TERMINAL SECTIONS SEE STANDARD DRAWING NO 89 FOR APPROACH AND DEPARTURE TERMINAL SECTIONS

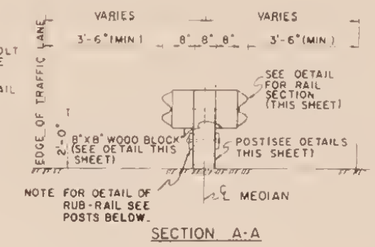
BRIDGE APPROACH SEE STANDARD DRAWING NO 86 FOR TREATMENT AT BRIDGE ENDS

REFLECTOR-WASHER ALL SECTIONS OF GUARD RAIL SHALL HAVE REFLECTOR WASHERS SPACED EVERY 25 FT. REFLECTOR WASHERS TO BE INCLUDED IN THE UNIT PRICE PER LINEAR FOOT OF GUARD RAIL. SEE DETAIL THIS SHEET

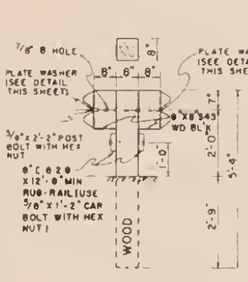
FITTINGS ALL FITTINGS SHALL BE GALVANIZED TO CONFORM WITH STANDARD SPEC M-220 C

METAL MEDIAN RAIL

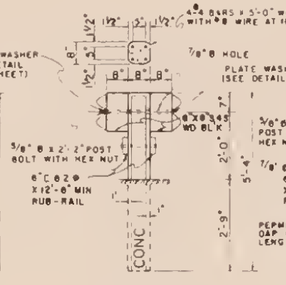




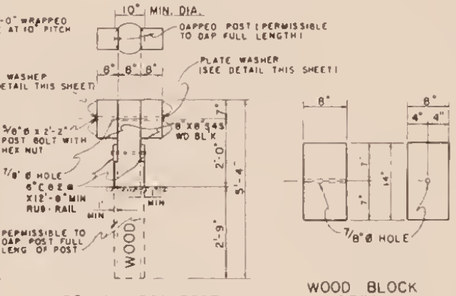
SECTION A-A



SQUARE WOOD POST


4-#4 BARS x 5'-0" WRAPPED WITH #8 WIRE AT 10" PITCH
7/8"ø HOLE
PLATE WASHER (SEE DETAIL THIS SHEET)
8" 8" 8"
8"X8"X43" WD BLK
5/8"ø x 2'-2" POST BOLT WITH HEX NUT
6"C 8.2 # X 12'-0" MIN RUB-RAIL
CONC
2'-9"
2'-0"
5'-4"

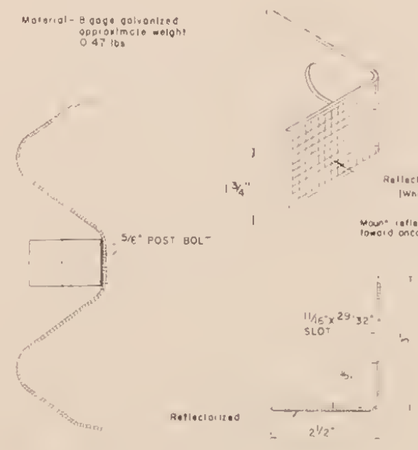
CONCRETE POST



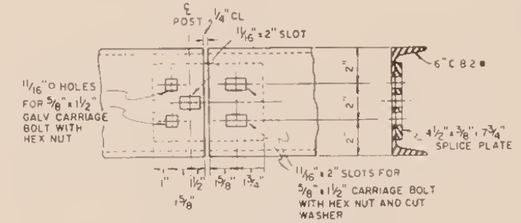
ROUND WOOD POST

WOOD BLOCK DETAIL

DETAIL OF GUARD RAIL POSTS



REFLECTOR - WASHER


℄ POST
1/4" CL
11/16"x2" SLOT
6"C 8.2 #
11/16" ø HOLES FOR 5/8"x1 1/2" GALV CARRIAGE BOLT WITH HEX NUT
4 1/2" x 3/8" x 7 3/4" SPLICE PLATE
11/16"x2" SLOTS FOR 5/8"x1 1/2" CARRIAGE BOLT WITH HEX NUT AND CUT WASHER
1" 1 1/2" 1 5/8" 1 3/4"
1 5/8"

DETAIL OF RUB RAIL SPLICE
(RAIL SPLICE TO OCCUR AT POSTS ONLY)

STANDARD DRAWING	
REFERENCE STANDARD SPEC SECTION 90	DWG NO 85
METAL GUARD AND MEDIAN RAIL	
APPROVED _____ STATE HIGHWAY ENGINEER	

REVISED			
EFFECTIVE			

DESIGN STANDARDS

The contents of the design standards were analyzed sheet-by-sheet. The following pages are examples of the standards before and after improvement. The first seven existing standards were replaced by a single standard sheet. This information was supplemented as required, and incorporated into the Design Manual.

The second example includes a typical memorandum which explains design criteria to be used on bituminous surfaced approaches. The information included in the Design Manual included a typical section, plan view and quantities for approach surfacing.

EFFECTIVE DATES	1-1-56	12-1-67		STANDARD SHEET NO. 20
	1-1-59			
State Highway Commission Helena, Montana				Approved State Highway Engineer

SUPERELEVATION AND RUNOFF
Related to
DESIGN SPEED AND CURVATURE

Degree of Curve	40 M.P.H.			50 M.P.H.			60 M.P.H.			70 M.P.H.		
	Crown Ft/Ft	2 Lane Ft	4 Lane Ft	Crown Ft/Ft	2 Lane Ft	4 Lane Ft	Crown Ft/Ft	2 Lane Ft	4 Lane Ft	Crown Ft/Ft	2 Lane Ft	4 Lane Ft
0° 15'	NC	0	0	NC	0	0	NC	0	0	NC	0	0
0° 30'	NC	0	0	NC	0	0	RC	200	200	RC	200	200
0° 45'	NC	0	0	RC	150	150	.02	200	200	.03	200	200
1° 00'	RC	150	150	.02	150	150	.03	200	200	.04	200	200
1° 30'	.02	150	150	.03	150	150	.04	200	200	.05	200	250
2° 00'	.03	150	150	.04	150	150	.05	200	250	.06	200	300
2° 30'	.03	150	150	.04	150	200	.06	200	250	.07	250	350
3° 00'	.04	150	150	.05	150	200	.07	200	300	.08	250	350
3° 30'	.04	150	150	.06	150	250	.07	200	300	Degree .08	Max.=3°30' 250	350
4° 00'	.05	150	150	.06	150	250	.08	250	350			
5° 00'	.06	150	200	.07	200	300	Degree .08	Max.=5°00' 250	350			
6° 00'	.06	150	200	.08	200	300						
7° 00'	.07	150	250	.08	200	300						
8° 00'	.07	150	250	Degree .08	Max.=7°30' 200	300						
9° 00'	.08	200	250									
10° 00'	.08	200	250									
11° 00'	.08	200	250									
12° 00'	.08	200	250									
	Degree .08	Max.=12°30' 200	250									

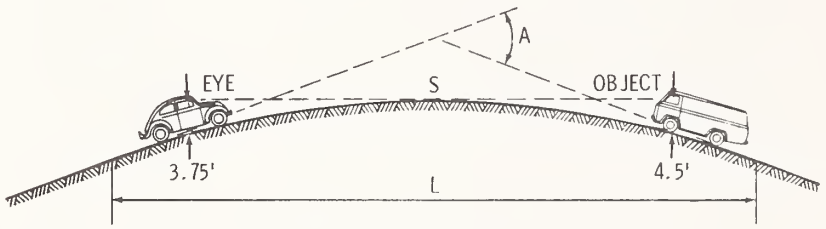
NOTE: Spirals shall be used on all curves 1°30' or greater with spiral lengths equal to the above lengths for runoff.

NOTE: Superelevation shall be rotated about profile grade and elevations less normal crown carried on the inside edge of the traffic lane.

NC - Normal Crown Section

RC - Remove adverse crown, superelevate at normal crown slope.

EFFECTIVE DATE	8-1-61 3-1-69	STANDARD SHEET NO. 22
State Highway Commission Helena, Montana	PASSING SIGHT DISTANCE FOR CREST VERTICAL CURVES	Approved -Thomas J. Judisch- 2-20-69- State Highway Engineer



FORMULAS:

WHEN S IS LESS THAN L

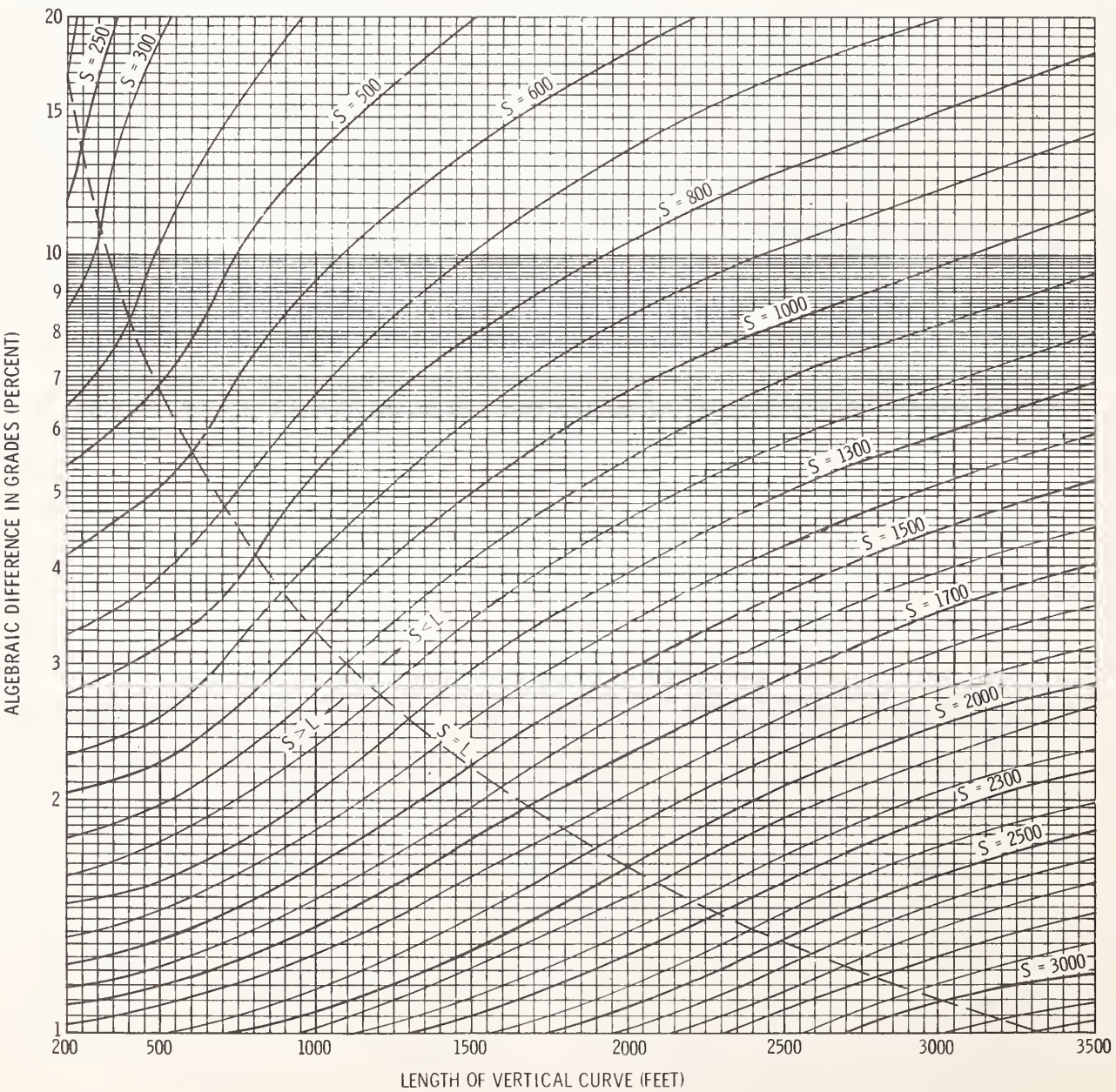
$$L = \frac{AS^2}{3295}$$

WHEN S IS GREATER THAN L

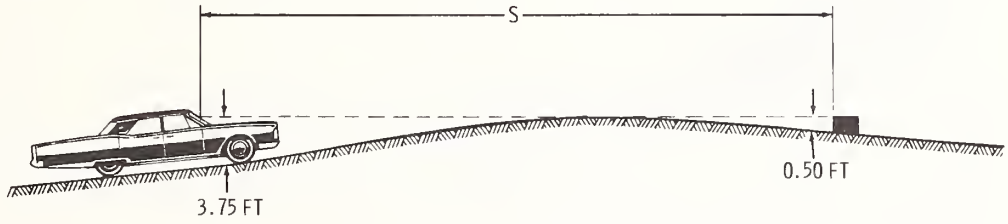
$$L = 2S - \frac{3295}{A}$$

S = SIGHT DISTANCE IN FEET
L = LENGTH OF VERTICAL CURVE IN FEET
A = ALGEBRAIC DIFFERENCE OF GRADES IN PERCENT

DESIGN SPEED (MPH)	25	30	35	40	50	60	70	80
MIN PASSING S.D. (FT)	800	1100	1300	1500	1800	2100	2500	2700



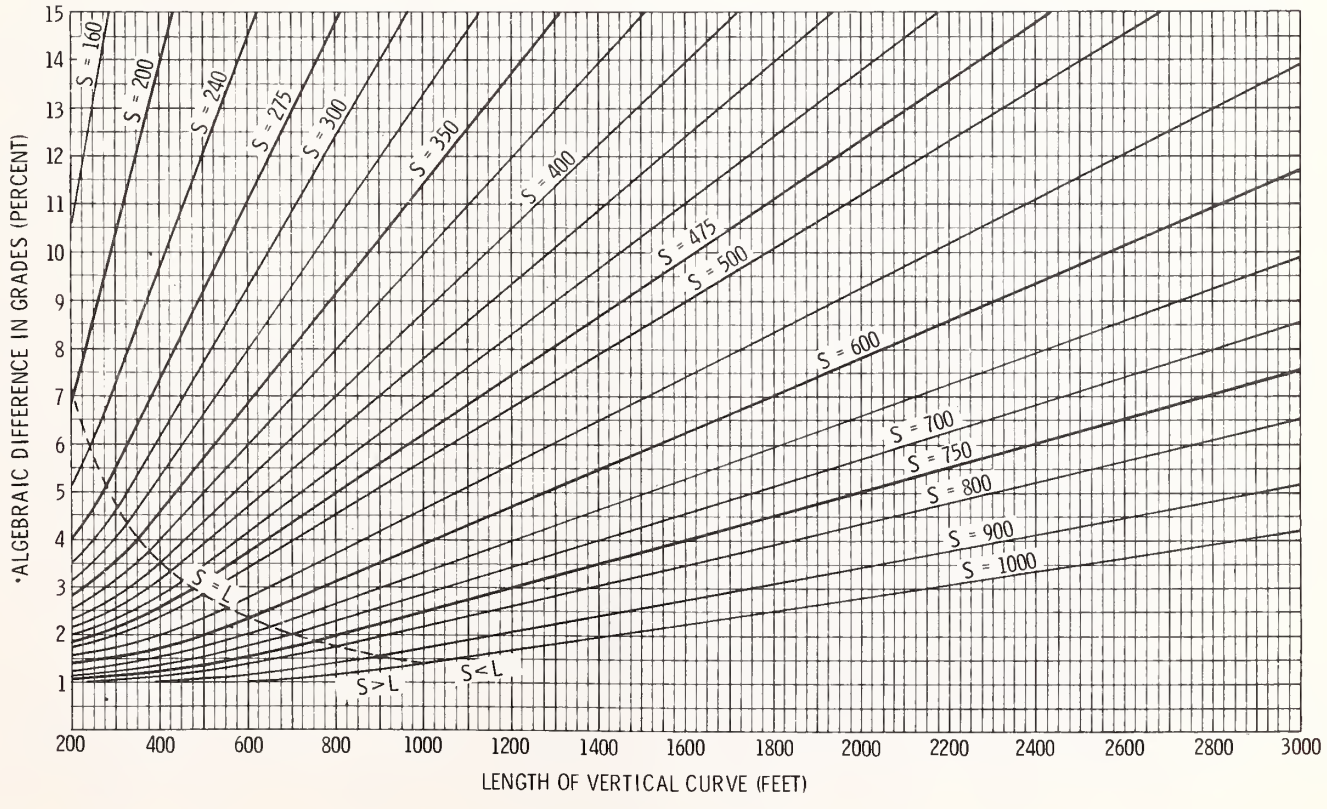
EFFECTIVE DATES	8-1-61 3-1-69	STANDARD SHEET NO. 23
State Highway Commission Helena, Montana	STOPPING SIGHT DISTANCE ON CREST VERTICAL CURVES	Approved State Highway Engineer



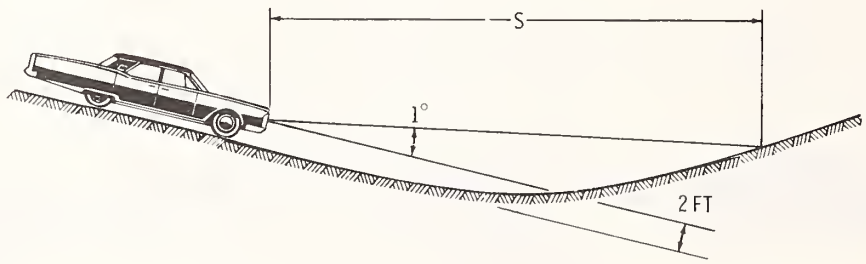
WHEN S > L	WHEN S < L
$L = 2S - \frac{1398}{A}$	$L = \frac{AS^2}{1398}$

L = CURVE LENGTH (FEET)
A = ALGEBRAIC GRADE DIFFERENCE (PERCENT)
S = SIGHT DISTANCE (FEET)

DESIGN SPEED (MPH)	MINIMUM STOPPING DISTANCE (FEET)	DESIRABLE MIN STOPPING DISTANCE (FEET)
25	160	200
30	200	240
35	240	275
40	275	350
50	350	475
60	475	600
70	600	750
80	750	900



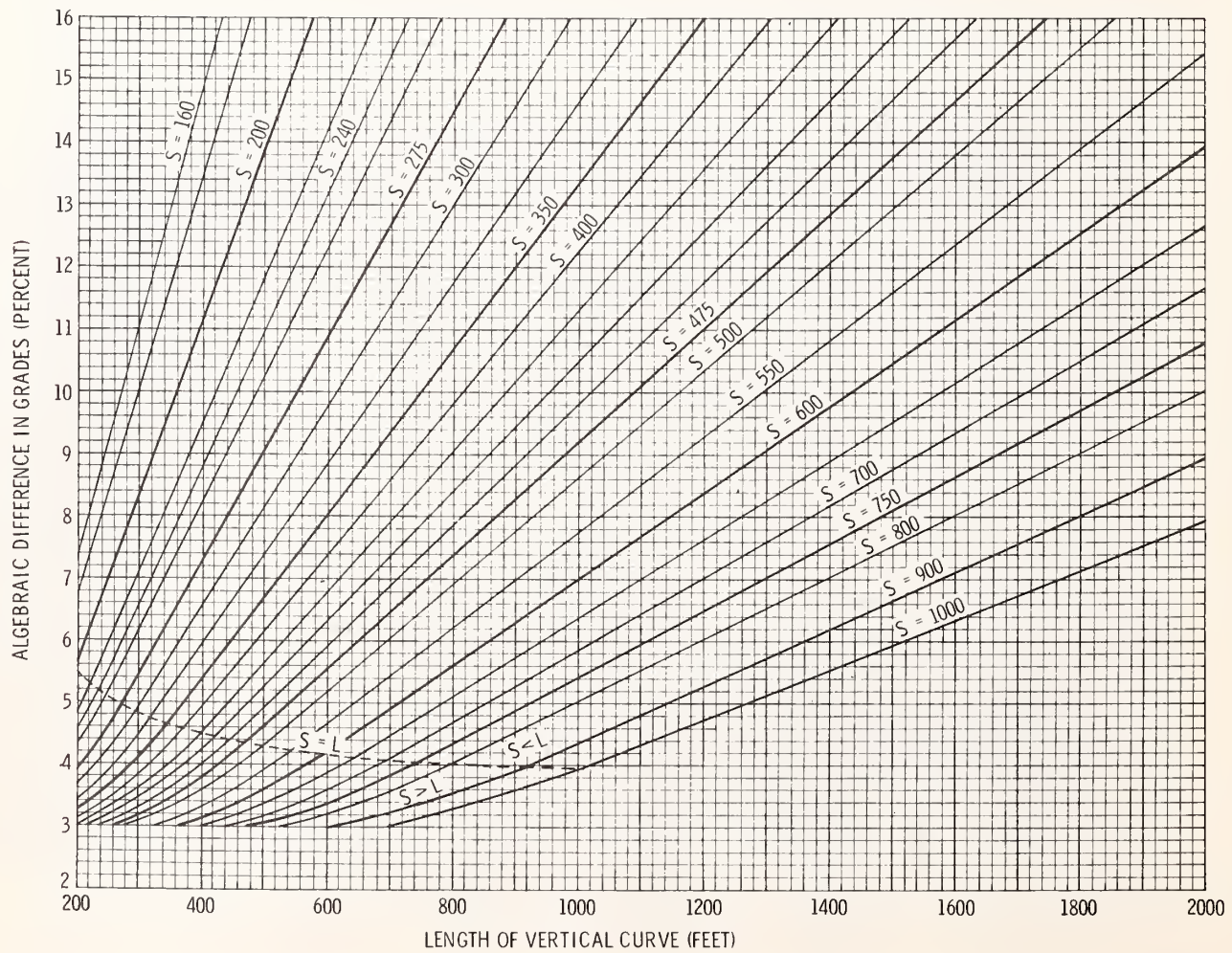
EFFECTIVE DATES	1-1-59 3-1-69	STANDARD SHEET NO. 24
State Highway Commission Helena, Montana	STOPPING SIGHT DISTANCE ON SAG VERTICAL CURVES	Approved Lewis A. Sullivan State Highway Engineer



WHEN S > L	WHEN S < L
$L = 2S - \frac{400 + 3.5S}{A}$	$L = \frac{AS^2}{400 + 3.5S}$

L = CURVE LENGTH (FEET)
A = ALGEBRAIC GRADE DIFFERENCE (PERCENT)
S = SIGHT DISTANCE (FEET)

DESIGN SPEED (MPH)	MINIMUM STOPPING DISTANCE (FEET)	DESIRABLE MIN STOPPING DISTANCE (FEET)
25	160	200
30	200	240
35	240	275
40	275	350
50	350	475
60	475	600
70	600	750
80	750	900



EFFECTIVE DATES	11-1-66	3-1-69		STANDARD SHEET NO. 31
	12-1-67	5-10-69		
State Highway Commission Helena, Montana		PRIMARY & SECONDARY DESIGN STANDARDS		Approved — Lawson M. Bottom 2/20/69 State Highway Engineer

**NOTE: Where terrain and grades make it possible to hold all backslope rounding catches at 10' from the R/W throughout a cut section and not incur slopes steeper than allowed or increase R/W width excessively, it shall be given consideration.

** CUT SLOPES

Cut Depth at Slope Stake	Level Terrain	Rolling Terrain	Mountain Terrain	*Solid Rock
0' - 5'	5:1	5:1	5:1	
5' -10'	4:1	4:1	3:1	SEE STANDARD
10' -15'	3:1	3:1	2:1	SHEET NO. 39
15' -20'	2:1	2:1	1½:1	
Over 20'	1½:1	1½:1	1:1	

Transition slopes shall be provided between adjoining cuts and fills

** See Note on Border FILL SLOPES

*Fill Depth at Slope Stake	Level Terrain		Rolling Terrain		Mountain Terrain		Rock
	Minim	Prefer	Minim	Prefer	Minim	Prefer	
0' - 5'	6:1	6:1	6:1	6:1	6:1	6:1	
5' -10'	4:1	6:1	4:1	6:1	4:1	6:1	
10' -15'	3:1	4:1	3:1	4:1	3:1	4:1	1½:1
15' -20'	2:1	4:1	2:1	4:1	2:1	4:1	1½:1
Over 20'	1½:1	2:1	1½:1	2:1	1½:1	2:1	1½:1

*See note on Std. Sheet #32

* MINIMUM VERTICAL CURVE LENGTHS

Terrain		Level	Rolling	Mountain
Design Speed		70 mph	60 mph	50 mph
STOPPING SIGHT DISTANCE	Stopping Distance, Ft.	600	475	350
	Crest Vertical Curve	2.55	1.60	0.85
	Sag Vertical Curve	1.45	1.05	0.75
PASSING SIGHT DISTANCE	Passing Distance, Ft.	2500	2100	1800
	Crest Vertical Curve	18.95	13.40	9.85

*Values given are coefficient by which the algebraic difference in grade may be multiplied to determine the length in Sta's of the vert. curve which will provide minimum sight distance. Special design where higher standards are not feasible. Subject to prior app. of Hdgtrs. MAXIMUM GRADES & HORIZONTAL CURVES

	Level Terrain Design Speed 70 mph	Rolling Terrain Design Speed 60 mph	Mountain Terrain Design Speed 50 mph	Special Design ⊠
Maximum Grade	3%	5%	6%	7%
Max. Horiz. Curve	3°30'	5°00'	7°30'	12°30'

⊠ Special design where higher stds. are not feasible. Subject to prior approval of headquarters.

ROAD WIDTHS

Future ADT *20 yr.	PRIMARY & SECONDARY MINIMUM WIDTHS		
	Mountainous	Rolling	Level
	50 mph	60 mph	70 mph
0-100	26	26	26
100-450	28	28	28
450-700	28	30	30
700-1400	34	34	36
1400-2800	40	40	40
Over 2800	44	44	44

Primary & Secondary Roads with future traffic volumes of 100 ADT or more to be Bit.-Surf. Low volume rds. are considered to be those having less than 100 ADT future traffic counts.

*In some case, traffic vol. may be given as design hourly volume (DHV) in such cases DHV X 7 = ADT

NOTE: Refer to Std. Sht. #20 for super elevations.

See Std. Sheet #30 or #32 for Interstate Standards.

Drawn Nov. 21, 1960	Last Revision Feb. 15, 1968	STANDARD SHEET NO. 30
State Highway Commission Helena, Montana	GEOMETRIC DESIGN STANDARDS FOR THE NATIONAL SYSTEM OF INTERSTATE & DEFENSE HIGHWAYS	Approved State Highway Engineer

Terrain Area		FLAT	ROLLING	MOUNTAINOUS	URBAN
Minimum Design Speed		70	60	50	50
Lane Width in Ft.		12	12	12	12
Number of Lanes		4	4	4	4
Shoulder Width - Ft.		10	10	10 ①	10
Maximum Curvature-Degree		3.5	5	7.5	7.5
Maximum Gradient - %		3	4	5 ②	5
Stopping Sight Distance-Ft.		600	475	350	350
Minimum Median Width - Ft.		36	36	16 ③	16 ③
Control of Access		Control of access is required for all sections of the Interstate System.			
Bridges and other Structures	Loading	SEE SHEET # 30-A			
	Clearance Width	SEE SHEET # 30-A			
	Vertical Distance	Not less than 17' over entire Interstate roadway, including shoulders.			
Railroad Separations		Railroad grade crossings shall be eliminated for all through traffic lanes.			

① In mountainous terrain involving high cost of additional width, the shoulder may be less but at least 6 feet.

② Gradients 2 percent steeper may be provided in rugged terrain.

③ Narrower medians may be provided in urban areas of high right-of-way cost, in rugged mountainous terrain and on long and costly bridges, but no median shall be less than 10 ft. wide. Where continuous barrier curbs are used on narrow medians, such curbs shall be offset at least 1 foot from the edge of the through traffic lane. Where vertical elements more than 12 inches high, other than abutments, piers, or walls, are located in a median, there shall be lateral clearance of at least $3\frac{1}{2}$ feet from the edge of the through traffic lane to the face of such element.

EFFECTIVE DATES	11-1-66	5-1-69		STANDARD SHEET NO. 32
	12-1-67			
STATE HIGHWAY COMMISSION Helena, Montana		INTERSTATE DESIGN STANDARDS		Approved by [signature] STATE HIGHWAY ENGINEER

*NOTE: Less than "Preferred Design" standards are to be used only where their application would result in extremely high cost. The use of 1½:1 slopes require prior analysis of slope stability.

** CUT SLOPES

CUT DEPTH AT SLOPE STAKE	LEVEL TERRAIN	ROLLING TERRAIN	MOUNTAIN TERRAIN	ROCK
0 - 5'	5:1	5:1	5:1	SEE STD.
5'-10'	4:1	4:1	3:1	SHEET NO.
10'-15'	3:1	3:1	2:1	39
Over 15'	2:1	2:1	1½:1	

Transition slopes shall be provided between adjoining cuts and fills. Slope and Benching recommendations by Geologist to be given carefull consideration.

**See Note on Border Std. Sheet No. 31

FILL SLOPES

*FILL DEPTH AT SLOPE STAKE	Level Terrain		Rolling Terrain		Mountain Terrain		Rock
	Minim	Prefer	Minim	Prefer	Minim	Prefer	
0' to 5'	6:1	6:1	6:1	6:1	6:1	6:1	
5' to 10'	4:1	6:1	4:1	6:1	4:1	6:1	
10' to 15'	3:1	4:1	3:1	4:1	3:1	4:1	1½:1
15' to 20'	2:1	4:1	2:1	4:1	2:1	4:1	1½:1
Over 20'	1½:1	2:1	1½:1	2:1	1½:1	2:1	1½:1

The above fill slopes are to pivot from a point on the 6:1 slope a distance of at least 15 feet from finished shoulder.

* See Note on border

*MINIMUM VERTICAL CURVE LENGTHS

TERRAIN		LEVEL	ROLLING	MOUNTAIN
DESIGN SPEED		70 MPH	60 MPH	50 MPH
STOPPING SIGHT DISTANCE	STOP. DIST. FEET	600	475	350
	CREST VERT. CURV.	2.55	1.60	0.85
	SAG VERT. CURVE	1.45	1.05	0.75

*Values given are the coefficient by which the algebraic difference in grade may be multiplied to determine the length in stations of the vertical curve which will provide minimum sight distance.

MAXIMUM GRADES

TYPE OF TOPOGRAPHY	DESIGN SPEED MPH			
	SPECIAL	50	60	70
FLAT				3%
ROLLING			4%	
MOUNTAINOUS	*7%	5%		

* Special design where higher standards are not feasible. Subject to prior approval.

MAXIMUM HORIZONTAL CURVATURE

DESIGN SPEED	50	60	70	
MAXIMUM DEGREE OF CURVE	7.5	5.0	3.5	

Based on maximum superelevation rate of 0.08' per foot.

EXAMPLE STANDARD SHEET

INTERSTATE

		Terrain or Area [9]			
		Flat	Rolling	Mountainous	Urban
Min. Design Speed, MPH		70	60	50	50
Max. Degree of Curvature [1]		3° 30'	5° 00'	7° 30'	7° 30'
Desirable Min. Stopping Sight Distance, Ft. [2]		850	650	450	450
Max. Gradient, %		3	4	5 [3]	5
Min. Widths, Ft.	Traffic Lanes	4 @ 12'	4 @ 12'	4 @ 12'	4 @ 12'
	Inside Shoulders [4]	4	4	4	4
	Outside Shoulders	10	10	10 [5]	10
	Median	36	36	16 [6]	16 [6]
Cut Slopes, Cut Depths at Slope Stake [7]	0' - 5'	5:1	5:1	5:1	-
	5' - 10'	4:1	4:1	3:1	-
	10' - 15'	3:1	3:1	2:1	-
	Over 15'	2:1	2:1	1½:1	-
Desirable Fill Slopes, Fill Depths at Slope Stake [8]	0' - 10'	6:1			
	10' - 20'	4:1			
	Over 20'	2:1			
Surface Slopes, Ft./Ft.	Crown	0.02			
	Inside Shoulder	0.02			
	Outside Shoulder	0.0375			

Median Width	Typical Section No.
36' to 44'	1
44' to 76'	2
76' and over	3
10'	4
12' to 20'	5

NOTES

1/ Based on the maximum superelevation rate of 0.08 ft./ft.

2/ The absolute minimum stopping sight distances are 600 ft., 475 ft., 350 ft. and 350 ft., respectively.

3/ Gradients up to 7% may be provided in rugged terrain, subject to prior approval.

4/ Inside shoulders will be 4' wide except where continuous barrier curbs are used on narrow medians. Curbs will be offset at least 1 ft., preferable 1.5 ft., from the edge of the traffic lane. Where vertical elements more than 12 in. high, other than abutments, piers or walls, are located in the median, the face of such element shall be offset at least 3.5 ft. from the edge of the traffic lane.

5/ Outside shoulders may be reduced to a minimum of 6 ft. in mountainous terrain involving high cost of additional width.

6/ Medians may be reduced to a minimum of 10 ft. in urban areas of high right-of-way cost, in rugged mountainous terrain and on long and costly bridges.

7/ For cut slopes in rock, use Standard Sheet No. 110.

8/ In rock fills over 10 ft. high, the standard fill slope is 1½:1. Except in rock fills, the absolute minimum fill slopes are 6 : 1 for 0' - 5', 4 : 1 for 5' - 10', 3:1 for 10' - 15', 2 : 1 for 15' - 20' and 1½ : 1 for over 20'. The use of 1½ : 1 slopes requires prior analysis of slope stability.

9/ Combinations of maximum design standards will require prior approval of the Administrator, Preconstruction Division.

PRIMARY AND SECONDARY

		Terrain [8]			
		Flat	Rolling	Mountainous	Special [7]
Min. Design Speed, MPH		70	60	50	40
Max. Degree of Curvature [1]		3° 30'	5° 00'	7° 30'	12° 30'
Desirable Min. Stopping Sight Distance, Ft. [2]		850	650	450	300
Min. Passing Sight Distance, Ft.		2500	2100	1800	1500
Max. Gradient, %		3	5	6	7
Roadway Widths, Ft., For Future ADT (20 years) [3]	0 - 100	26	26	26	26
	100 - 450	28	28	28	28
	450 - 700	30	30	28	28
	700 - 1400	36	34	34	34
	1400 - 2800	40	40	40	40
	Over 2800	44	44	44	44
Cut Slopes, Cut Depths at Slope Stake [4]	0' - 5'	5:1	5:1	5:1	5:1
	5' - 10'	4:1	4:1	3:1	3:1
	10' - 15'	3:1	3:1	2:1	2:1
	15' - 20'	2:1	2:1	1½:1	1½:1
	Over 20'	1½:1	1½:1	1½:1	1½:1
Fill Slopes, Fill Depths at Slope Stake [5]	0' - 10'	6:1			
	10' - 20'	4:1			
	Over 20'	2:1			
Surface Slopes, Ft./Ft.	Crown	0.02 [6]			
	Shoulder				

Roadway Width	Typical Section No.
28' to 44'	6
26'	7

NOTES

1/ Based on the maximum superelevation rate of 0.08 ft./ft.

2/ The absolute minimum stopping sight distances are 600 ft., 475 ft., 350 ft. and 350 ft., respectively.

3/ Each roadway width comprised of two 12 ft. traffic lanes plus shoulders.

4/ For cut slopes in rock, use Std. Sht. No. 110.

5/ In rock fills over 10 ft. high, the standard fill slope is 1½ : 1. Except in rock fills, the absolute minimum fill slopes are 6:1 for 0' - 5', 4:1 for 5' - 10', 3:1 for 10' - 15', 2:1 for 15' - 20' and 1½:1 for over 20'. The use of 1½:1 slopes requires prior analysis of slope stability.

6/ Shoulder slope same as crown slope except as shown on typical sections.

7/ This column will be used only with the prior approval of the Preconstruction Engineer.

8/ Combinations of maximum design standards will require prior approval of the Administrator Preconstruction Division.

REVISIONS		MONTANA DEPARTMENT OF HIGHWAYS
DATE	BY	GEOMETRIC DESIGN STANDARDS
		APPROVED STATE HIGHWAY ENGINEER
		STANDARD SHEET NO 101

S. H. COMM.--FORM 4

INTER-DEPARTMENTAL MEMORANDUM

STATE HIGHWAY COMMISSION OF MONTANA

To ALL DESIGN PERSONNEL Date May 10, 1967

From G.B.Woodahl,P.E., Road Design Engineer Subject: Bituminous Surfaced Approaches

All approaches on Bituminous Surfaced Projects are to be bituminous surfaced to the right of way line. Exceptions would be occasional or seasonally used approaches, and these should be gravel surfaced to the right of way line. Determination of the type of surfacing to be made at the time of plan in hand inspection.

Unless otherwise shown on the plans, the following surfacing depths shall be used:

0.125' Comp. Plant Mix or Road Mix Bituminous Surfacing.
0.20' Comp. Ave. Depth Top Surfacing-Type 'A'-Leveling Crse.
0.50' Comp. Crushed Base Course-Type 'A'

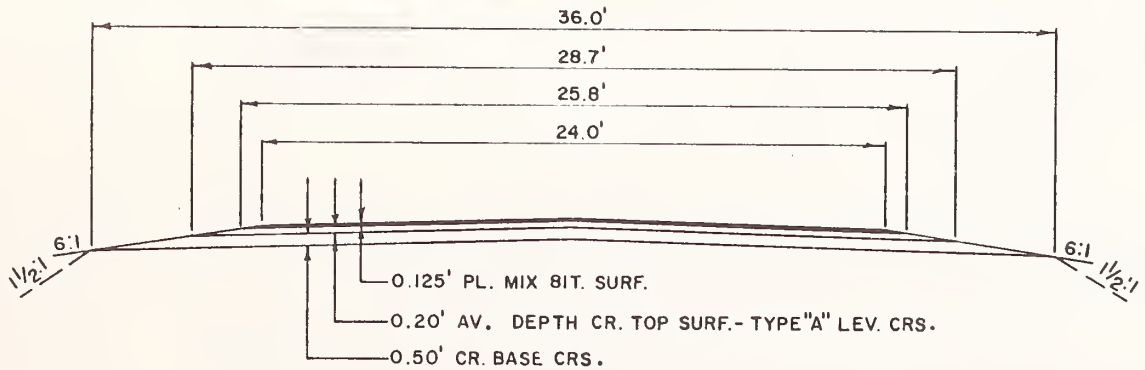
G.B. Woodahl

32-GBW/gw

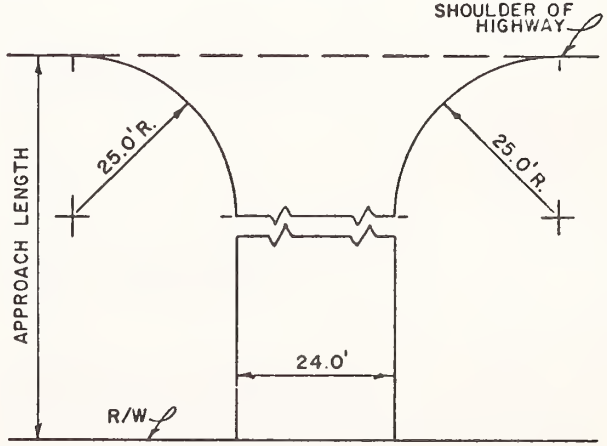
Avoid Verbal Instructions

EXAMPLE STANDARD SHEET

TYPICAL SECTION



PLAN



Quantities Per Approach (Incl. Wyes - 25' Radius)								
App. Length (Ft.)	Tons (Grav. Est. @ 3700 lbs.)					Tons Bit. Mat'l.		
	Cov. Mat'l.	Pl. Mix*	Cr. Top	Cr. Base		Pl. Mix ($6\frac{1}{2}$%)	** Prime	** Seal
25	1	8	14	40		0.5	0.1	0.1
30	1	9	16	45		0.6	0.2	0.2
35	2	10	17	51		0.7	0.2	0.2
40	2	11	19	57		0.7	0.2	0.2
45	2	13	21	62		0.8	0.2	0.2
50	2	14	23	68		0.9	0.2	0.2
55	2	15	24	73		1.0	0.2	0.2
60	3	16	26	79		1.0	0.3	0.3
65	3	17	29	85		1.1	0.3	0.3
70	3	18	31	90		1.2	0.3	0.3
75	3	19	33	95		1.2	0.3	0.3
80	3	20	34	101		1.3	0.3	0.3
85	3	21	36	107		1.4	0.4	0.4
90	4	23	38	112		1.5	0.4	0.4
95	4	24	40	117		1.5	0.4	0.4
100	4	25	41	124		1.6	0.4	0.4

*Incl. Weight of Pl. Mix Mat'l. Comp. Wt. Pl. Mix = 128.5 lbs. per sq. yd. per 0.10' thickness.
**Based on 0.30 gallons per square yard.

REVISIONS		MONTANA DEPARTMENT OF HIGHWAYS
DATE	BY	
		ESTIMATED QUANTITIES FOR APPROACH SURFACING
		APPROVED
		STATE HIGHWAY ENGINEER
		STANDARD SHEET NO 901

WORK METHODS

Analysis of the current work methods had the following objectives:

1. To determine the effectiveness of the current work systems employed.

2. To collect pertinent data relative to work methods utilized in the accomplishment of work.

3. To identify effective work methods.

4. To define the expected results from work effort.

5. To identify bases for the development of meaningful standards.

EXAMPLE OF PROJECT COST ANALYSIS

COSTS AND MAN-HOURS BY PROJECT AND OCCUPATION CODE

	PROJ	AGR	UN	OC COD	HW QUANT	FD QUANT	TOT QTY	AMOUNT
OCC CODE TOTAL	3128	04	00	171	.00	8.00	8.00	$2,168.56
OCC CODE TOTAL	3128	04	00	172	.00	80.00	80.00	$432.42
OCC CODE TOTAL	3128	04	00	191	.00	356.00	356.00	$877.67
OCC CODE TOTAL	3128	04	00	192	.00	316.00	316.00	$5,580.11
OCC CODE TOTAL	3128	04	00	195	.00	624.00	624.00	$5,445.35
OCC CODE TOTAL	3128	04	00	200	.00	160.00	160.00	$3,793.49
OCC CODE TOTAL	3128	04	00	233	8.00	.00	8.00	$50.96
OCC CODE TOTAL	3128	04	00	238	32.00	.00	32.00	$210.85
OCC CODE TOTAL	3128	04	00	253	.00	.00	.00	$254.02
UNIT TOTAL	3128	04	00		756.00	2,276.00	3,032.00	$25,444.87
AGREMENT TOTAL	3128	04			756.00	2,276.00	3,032.00	$25,444.87
OCC CODE TOTAL	3128	06	00	211	4.00	.00	4.00	$18.00
UNIT TOTAL	3128	06	00		4.00	.00	4.00	$18.00
AGREMENT TOTAL	3128	06			4.00	.00	4.00	$18.00
OCC CODE TOTAL	3128	07	00	117	16.00	.00	16.00	$74.86
OCC CODE TOTAL	3128	07	00	120	72.00	.00	72.00	$274.13
OCC CODE TOTAL	3128	07	00	130	24.00	.00	24.00	$67.85
OCC CODE TOTAL	3128	07	00	131	52.00	.00	52.00	$187.98
OCC CODE TOTAL	3128	07	00	160	.00	80.00	80.00	$340.39

EXAMPLE OF PROJECT COST ANALYSIS
COSTS AND MAN-HOURS BY PROJECT, ORGANIZATION AND OCCUPATION CODE

3128

	AGR	UN	AR-BY	OC COD	HQ QUANT	FD QUANT	TOT QTY	AMOUNT
OCC CODE TOTAL	04	00	4130	191	.00	356.00	356.00	$877.67
OCC CODE TOTAL	04	00	4130	192	.00	316.00	316.00	$5,580.11
OCC CODE TOTAL	04	00	4130	195	.00	624.00	624.00	$5,445.35
OCC CODE TOTAL	04	00	4130	200	.00	160.00	160.00	$3,793.49
OCC CODE TOTAL	04	00	4130	253	.00	.00	.00	$254.02
AREA-BY TOTAL	04	00	4130		.00	2,276.00	2,276.00	$22,505.10
UNIT TOTAL	04	00			756.00	2,276.00	3,032.00	$25,444.87
AGREMENT TOTAL	04				756.00	2,276.00	3,032.00	$25,444.87
OCC CODE TOTAL	06	00	0031	211	4.00	.00	4.00	$18.00
AREA-BY TOTAL	06	00	0031		4.00	.00	4.00	$18.00
UNIT TOTAL	06	00			4.00	.00	4.00	$18.00
AGREMENT TOTAL	06				4.00	.00	4.00	$18.00
OCC CODE TOTAL	07	00	0030	130	24.00	.00	24.00	$67.85
OCC CODE TOTAL	07	00	0030	238	8.00	.00	8.00	$55.25
AREA-BY TOTAL	07	00	0030		32.00	.00	32.00	$123.10
OCC CODE TOTAL	07	00	0031	201	16.00	.00	16.00	$56.69
AREA-BY TOTAL	07	00	0031		16.00	.00	16.00	$56.69
OCC CODE TOTAL	07	00	0032	131	4.00	.00	4.00	$15.07
AREA-BY TOTAL	07	00	0032		4.00	.00	4.00	$15.07
OCC CODE TOTAL	07	00	0033	117	16.00	.00	16.00	$74.86

EXAMPLE OF PROJECT COST ANALYSIS
COSTS AND MAN-HOURS BY PROJECT, TRAFFIC AND HYDRAULIC ORGANIZATION, OCCUPATION CODE

3128

	AGR	UN	AR-BY	OC COD	TOT QTY	AMOUNT
OCC CODE TOTAL	04	00	0034	117	48.00	$211.30
OCC CODE TOTAL	04	00	0034	129	16.00	$39.52
OCC CODE TOTAL	04	00	0034	131	16.00	$51.42
OCC CODE TOTAL	04	00	0034	163	48.00	$291.45
OCC CODE TOTAL	04	00	0034	165	64.00	$208.20
AREA-BY TOTAL	04	00	0034		192.00	$801.89
OCC CODE TOTAL	04	00	0036	120	8.00	$31.06
AREA-BY TOTAL	04	00	0036		8.00	$31.06
UNIT TOTAL	04	00			200.00	$892.95
AGREMENT TOTAL	04				200.00	$892.95
OCC CODE TOTAL	07	00	0034	117	56.00	$246.50
OCC CODE TOTAL	07	00	0034	163	24.00	$148.08
OCC CODE TOTAL	07	00	0034	165	32.00	$134.97
AREA-BY TOTAL	07	00	0034		112.00	$529.55
UNIT TOTAL	07	00			112.00	$529.55
AGREMENT TOTAL	07				112.00	$529.55
PROJECT TOTAL					312.00	$1,422.50

EXAMPLE OF METHODS STUDIES CONDUCTED

METHODS STUDY WORKSHEET

ACTIVITY: Plotting Land Lines

ACCOMPLISHMENT UNIT: Miles

NUMBER OF MEN:

FUNCTION OF EACH: Draftsman

EQUIPMENT: Range and Township maps, straight edge, linen, pencil, calculator and lettering guide.

OBSERVER COMMENTS: Very little trouble plotting land lines. Problems occurred at quarter section corners. Quarter sections might be a good unit of measure. Measurements are taken in rods then converted to scale. Measurement is continuous from one sheet to the next until a tie is reached. Note: one curve on alignment. Fifty corners had to be located. Completed 6.93 miles or 366.13 Sta.

	TIME		DESCRIPTION
	Beginning	End	
+ 3 Hr.		3 Hr.	Time to gather reference material and plot 4 township lines.
+20	8:25	8:45	Sheet 2-5 section desc. and 3 lot desc.
+36	8:45	9:21	Sheet 3 - 2 st. land lines and 2 sections disc.
+ 1	9:21	9:22	Sheet 3
- 4	9:22	9:26	Talking
+17	9:26	9:43	Sheet 3 Error of 13' required proration
- 3	9:43	9:46	Instruction
+28	9:46	10:14	Complete Sheet 4
- 6	10:14	10:20	Talking
+25	10:20	10:45	Solving a problem
+55	10:45	11:40	Sheets 4 and 5
+91	1:05	2:36	Sheet 6
-11	2:36	2:47	Break
+16	2:47	3:03	Working
- 5	3:03	3:08	Instruction
- 1	3:08	3:09	Talking
+20	3:09	3:29	Working
+24	3:33	3:57	Complete sheets 6 and 7

EXAMPLE SHEET FROM SPECIAL REPORTING SYSTEM

ACTIVITY: Designing Typical Sections SECTION: East Region

UNIT OF MEASURE: Man-hours per each CLASSIFICATION: Designer II

ACTIVITY DESCRIPTION: The design of the horizontal characteristics of the section given the structural characteristics and calculating the quantities from the end areas of the sections.

DATE	ACTUAL HOURS	ACTUAL ACCOMPLISHMENT	DATE	ACTUAL HOURS	ACTUAL ACCOMPLISHMENT	DATE	ACTUAL HOURS	ACTUAL ACCOMPLISHMENT
3/24/71	1 hr.							
3/25/71	3 hr.							
3/26/71	6 hr.							
3/29/71	8 hr.							
3/30/71	8 hr.							
3/31/71	4 hr.							
4/6/71	8 hr.							
4/7/71	6 hr.							
7/8/71	8 hr.							
4/15/71	2 hr.							
4/20/71	7 hr.							
4/21/71	7 hr.							
4/22/71	7 hr.							
4/23/71	2 hr.	29 Typicals						
5/3/71	7 hr.							
5/4/71	7 hr.	7 Typicals						

EXAMPLE SHEET FROM SPECIAL REPORTING SYSTEM

ACTIVITY: Plotting Cross Sections SECTION: West Region

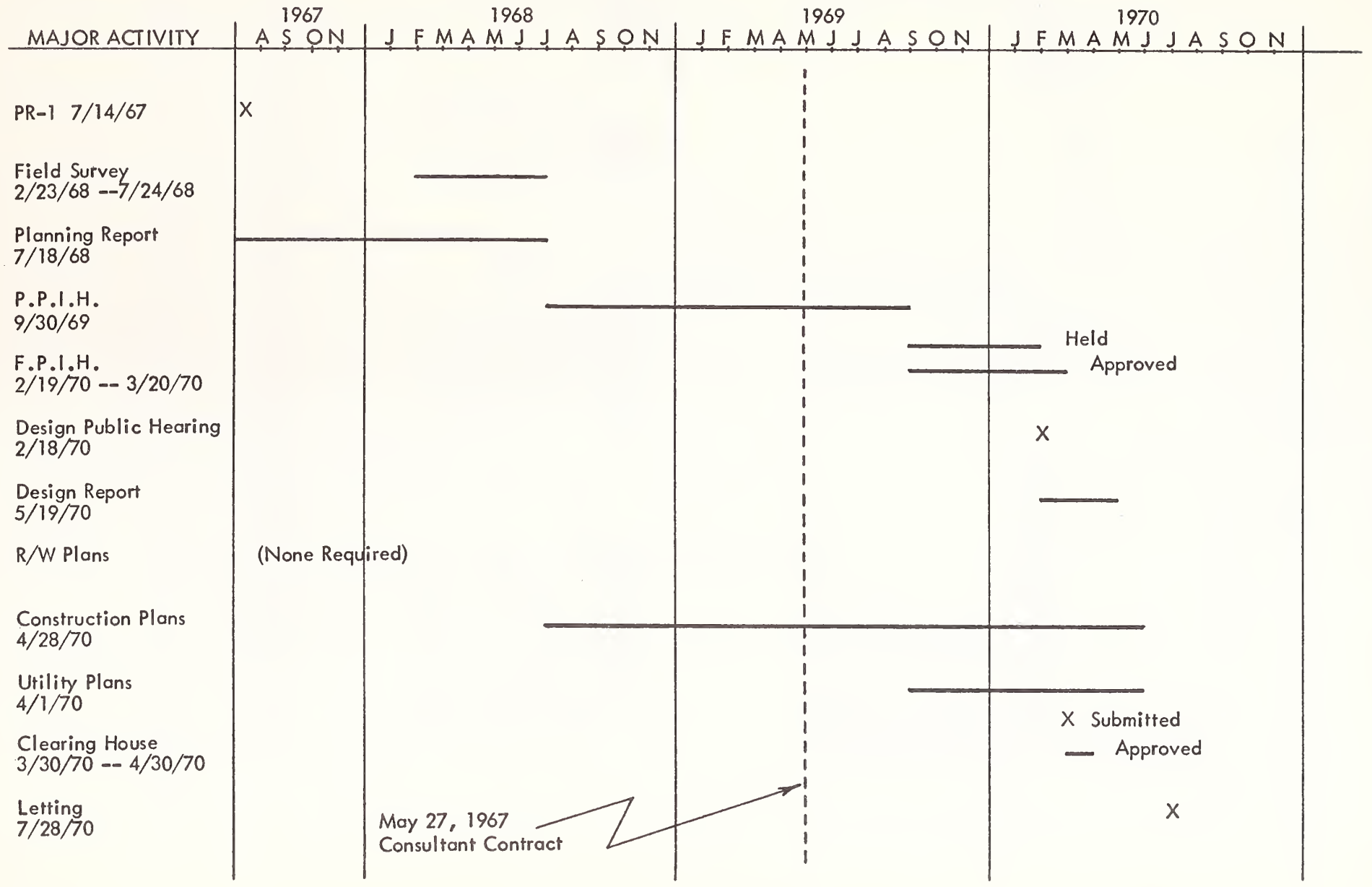
UNIT OF MEASURE: Man-hours per Station CLASSIFICATION: Draftsman II and III

ACTIVITY DESCRIPTION: **The plotting of ground line data on cross section sheets and checking the plotted information.**

		Stations	No. of Man-Hours			Stations	No. of Man-Hours			
DATE	ACTUAL HOURS	ACTUAL ACCOMPLISHMENT		DATE	ACTUAL HOURS	ACTUAL ACCOMPLISHMENT		DATE	ACTUAL HOURS	ACTUAL ACCOMPLISHMENT
3 - 30	2	3	1	5 - 3	7	15	1			
3 - 31	4	17	2	5 - 4	7	17	1			
4 - 8	4	19	2	5 - 5	7	25	1½			
4 - 9	4	18	1½	5 - 6	7	40	2			
4 - 12	7	30	2	5 - 7	7	42	2			
4 - 13	7	30	2	5 - 10	3	5	1			
4 - 14	7	15	1	5 - 11	7	39	2			
4 - 15	7	20	1½	5 - 12	7	42	2			
4 - 16	7	30	2	5 - 13	7	41	2			
4 - 19	7	35	2	5 - 14	7	15	1			
4 - 20	7	40	2	5 - 17	7	41	2			
4 - 21	7	40	2	5 - 18	4	17	1½			
4 - 22	6	30	2							
4 - 23	7	15	1							
4 - 26	7	43	2							
4 - 27	7	40	2							
4 - 28	7	41	2							
4 - 29	7	40	2							
4 - 30	7	41	2							

EXAMPLE ELAPSED TIME ANALYSIS BY PROJECT

190 - 9(21) -- ADD TWO LANE -- 5.071 MILES



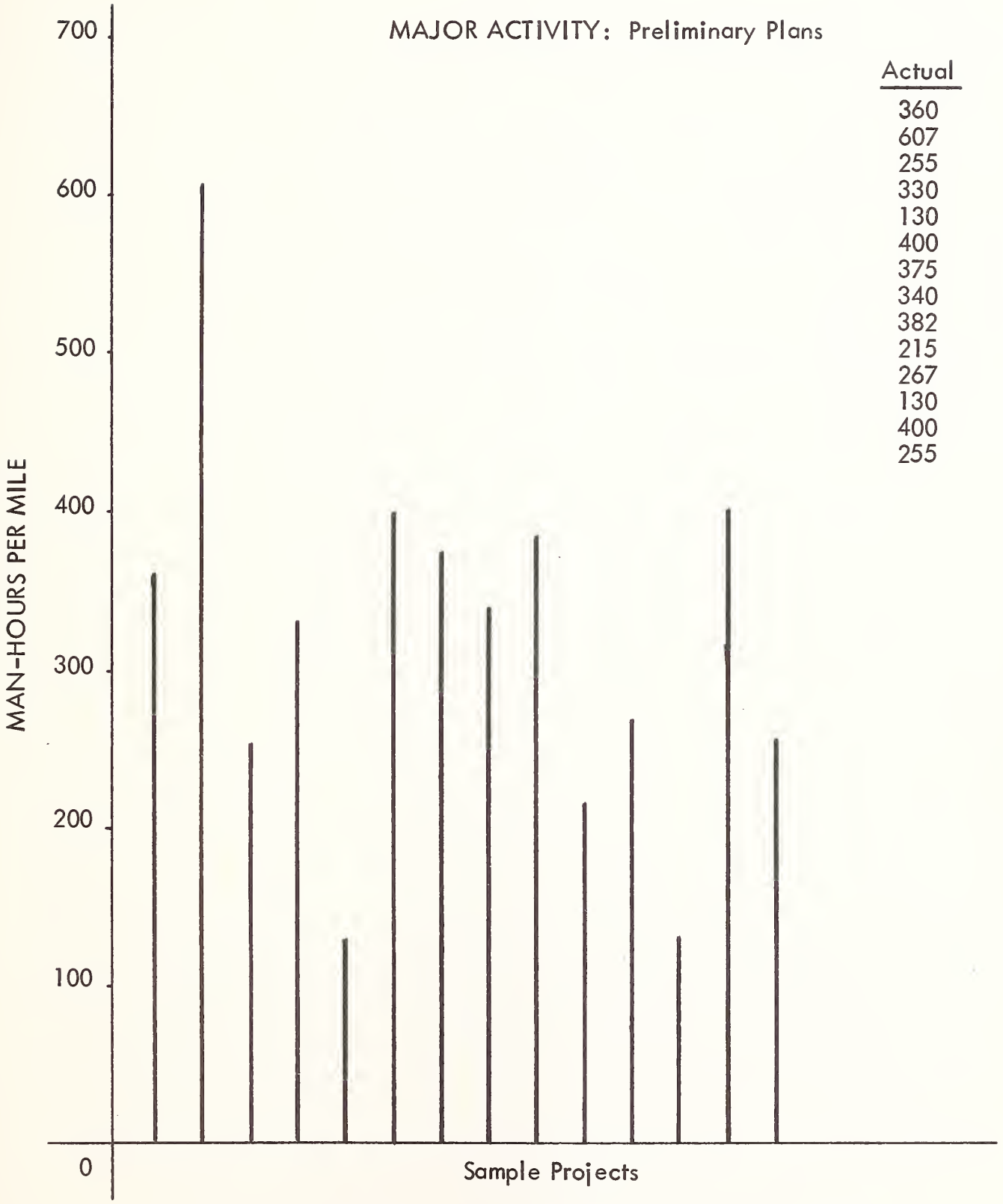
CONSULTANT ESTIMATE ANALYSIS

Major Activity Description	Man-Hours per Activity Range	Weighted Average
Preliminary Plans	130 to 607	325
Design Plans	330 to 1,500	473
Utility Plans	5 to 257	78
Fencing Plans	20 to 135	68
Signing Plans	25 to 125	61
Right-of-Way Plans	150 to 295	207

Special Design	Unit of Measure	Man-Hours per Unit Range	Weighted Average
Interchange Geometrics	Per Each	172 to 330	267
Frontage Road	Per Mile	50 to 150	100
Hydraulic Analysis	Per Major Unit	35 to 120	65
Rest Areas	Per Unit	100 to 400	245
Bridge Situations	Per Unit	10 to 20	17

Note: Analysis conducted on 14 sample projects. All projects selected had comparable characteristics.

EXAMPLE CONSULTANT ESTIMATE
ANALYSIS BY PROJECT



IMPROVED WORK SYSTEMS

CONTENTS

WORK STANDARDIZATION

+ Contract plans content and format report
+ Standard drawing index
+ Contract plans procedure
+ Work flow diagrams
+ Road design check list

MONTANA
STATE HIGHWAY COMMISSION
PRECONSTRUCTION DIVISION

CONTRACT PLANS

STANDARDIZATION REPORT

September 9, 1970

Standards for preparing contract plans in the Preconstruction Division are summarized in this report. The standards are recommended by the following Commission personnel serving as the Contract Plans Committee:

Jay Duba, Resident Engineer, Construction Division
Dave Johnson, Regional Engineer, Preconstruction Division (East)
Steve Kologi, Regional Engineer, Preconstruction Division (West)
James Sahinen, Assistant Consultant Design Engineer, Preconstruction Division
Robert Skow, Designer III, Preconstruction Division (West)

The plans standardization effort was guided and directed by:

Roy Jorgensen Associates, Inc.
Management Consultants
Gaithersburg, Maryland 20760

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FOREWORD

A project to develop a design management system was undertaken by Roy Jorgensen Associates, Inc., for the Montana State Highway Commission under an agreement dated August 3, 1970.

One objective of the project was to standardize the format and content of contract plans prepared by the Preconstruction Division.

This report has reference to the plans standardization phase of the project. It summarizes the findings, conclusions and recommendations of the Contract Plans Committee.

The standardization recommendations, when approved, will be included in a manual setting forth guidelines to be used for preparing contract plans. The manual will be supplemented by a set of model plans showing how the standards are to be implemented.

SUMMARY OF CONTRACT PLANS COMMITTEE FINDINGS

Characteristics of the format and content of the current contract plans are listed below.

1. Only a general pattern is followed in sequencing the plan sheets in the set, and this pattern is not followed consistently.

2. The indexing and pagination of the plans is inadequate. Many people find information in the plans by "thumbing through." Current indexing and pagination practices make it nearly impossible for plan users to determine whether or not their plan sets are complete and up-to-date.

3. Some sheets contain data which should be located elsewhere within the plans.

4. Some sheets contain too much data for single sheets.

5. The same symbols and abbreviations are used to represent different things, and identical things are represented by different symbols and abbreviations.

6. Many data are duplicated several times in the plans.

7. All sheets contain data no longer needed in the plans.

8. Some sheets should show data that currently are not included in the plans.

SUMMARY OF PRINCIPAL CONCLUSIONS

The findings summarized above led to four principal conclusions:

1. Many of the difficulties in communicating design decisions to contractors and construction inspection personnel can be reduced or eliminated by adopting uniform ways of setting things forth in the plans: standard terms, abbreviations and symbols; standard plan sheet layouts; and, standard plan set organization.

2. Many of the difficulties in preparing contract plans can be reduced or eliminated by deleting unnecessary data and duplicate data. Duplication of data causes plans preparation, revision and checking to be unnecessarily time-consuming and unnecessarily subjects the data to error and contradiction.

3. It would be difficult to train new Commission personnel to read, interpret and use the contract plans until consistency is established in the ways design personnel set forth the information.

4. All persons who participate in the development of contract plans should have access to and should use the standards recommended by the Contract Plans Committee.

RECOMMENDED STANDARDS

Terms, Symbols and Abbreviations

The term "Summary" no longer will be used to describe sheets in the contract plans. Summary sheets will be divided into four categories of sheets: notes sheets, typical section sheets, bid item sheets and detail sheets.

The symbols shown in Exhibit 1 and abbreviations shown in Exhibit 2 will be used with consistency on all sets of plans -- and will be printed on the back of every title sheet.

Title Sheet

The title sheet will show a state map and the design data required by the Bureau of Public Roads in the upper left corner.

Project title information will be shown in the top center of the sheet in this order:

1. Montana Highway Commission
2. Project construction number
3. Project name
4. Contract numbers and type of work for each contract
5. County name
6. Project length
7. Scales of plan and profile sheets, cross section and reduced sheets

Layout map scales will be one inch per mile. Each layout map will clearly show:

+ the location of the project roadway in relation to true north, nearby townships, ranges, sections, existing roads, towns, major drainage, state optioned borrow sources, railroads, and buildings.

+ the beginning and ending stations of the project and stations of other projects into which they tie.

+ major equations.

+ the contract number for which the plans were prepared, and

+ bridges on the project, a single station location for each bridge, the length of each bridge and whether each bridge is an overpass or an underpass.

Project numbers for right-of-way, incidental construction and preconstruction engineering will be shown in the lower left corner of the title sheet.

The letting date will be shown in the upper right corner under the sheet identification box.

The project approval block will be shown in the lower right corner of the title sheet.

Table of Contents Sheet

A table of contents will be included in each set of contract plans. One sheet will be used solely for this purpose, except in plans that include so few sheets and notes that both the table of contents and the plan notes can be readily placed on the same sheet.

Each table of contents will include lists of items in the plans in sufficient detail to make it easy to find each item. All other indices will be deleted.

Sheet Numbers

All plan sheets will be numbered in sequence from the title sheet to the final sheet. The title sheet will be sheet number one, the symbols and abbreviations will be sheet number two and the table of contents will be sheet number three.

Any sheets printed on both sides will be numbered separately on each side.

No sheets will be numbered 8A, 8B, 8.1, 8.2 or in any way other than a separate, sequential whole number.

Sheets added to a set of plans, such as change-order sheets, will be numbered sequentially as Appendix 1, Appendix 2, and so on. Sheets added to or deleted from a set of plans will be noted on the table of contents sheet.

As the contents of a set of plans are revised, the revision date will be noted on the table of contents sheet.

The last sheet number on the table of contents will indicate the total number of sheets in the set of plans. This total number will change as appendix sheets are added -- and as sheets are deleted -- so that all plan users will be able to identify any missing plan sheets.

Notes Sheet

All general notes will be placed on a notes sheet. The notes sheet will include:

+ Descriptions of items to be removed by non-contractor personnel

+ Descriptions of work procedures to be used by the contractor

+ Descriptions of work items absorbed in the costs of bid items

+ Bases for plan quantities of surfacing materials, and

+ Instructions for interpreting the plans, such as:

  "R/W line = control of access unless otherwise noted" and

  "Unless otherwise specified, items within the R/W limits will be removed or moved by others."

+ Instructions to refer to cross sections and standard drawings for slope details

Typical Section Sheets

One or more separate sheets will be used to show all typical sections. All typical sections will be orientated horizontally.

Main line typical sections will be shown first, followed by other typical sections in the order they appear along the main line.

All typical sections will be numbered in sequence from the first main line typical section to the final typical section. The first typical section will be typical section number one, the second typical section will be typical section number two, and so on.

No typical sections will be numbered 6A, 6B or in any way other than a separate sequential whole number.

The name of the roadway to which a typical section applies will be shown conspicuously immediately under the typical section number.

Station limits within which typical sections apply will be conspicuously shown in the upper right corner of each typical section diagram.

Bid Items Sheet

One or more separate sheets will be used to summarize quantities of bid items. Notes and other items will not be placed on bid item sheets.

Summaries of bid items will be arranged in the order that they appear in the contract, except that culverts, alternate culverts and surfacing summaries will be located at the end of the bid items in that order.

Linear and Level Data Sheet

One or more separate sheets will be used to summarize linear and level data for the project. The linear and level data sheet will show a summary of project lengths, the sources of bearing and bench mark data and a tabulation of all bench mark data for the project.

Bench mark tabulations will show the location, description and elevation of each bench mark. Bench marks whose locations are referenced to mainline stationing will be shown first, followed by bench marks whose locations are based on other lines in the order they appear along the mainline.

The road or line to which a group of bench marks is referenced will be conspicuously shown. Each group of bench marks will be tabulated in the order of increasing stations.

Detail Sheets

One or more detail sheets will be used to show details of non-standard hydraulic structures.

Each "Detail" sheet will be clearly labeled. Only the name of the detail, the station to which it applies and the scale to which it is drawn will be shown in the lower right corner of the space allotted to the detail.

The initials of the persons who drew and checked the detail and the dates of drawing and checking will appear in the lower left corner of the space allotted to the detail.

Plan and Profile Sheets

All mainline plan and profile sheets will be shown first, in the order of increasing stationing. The continuous stationing of the mainline plan and profile sheets will not be interrupted by special sheets showing details on or near the mainline.

Special plan and profile sheets showing details of connections, interchanges, intersections, detour roads, frontage roads, railroads and so on, will appear after the mainline plan and profile sheets in the order they appear along the mainline.

Special plan and profile sheets for each interchange will be arranged in this order:

1. Plan and profile
2. Plan view of geometric layout
3. Ramp profiles
4. Contour map

Each special plan and profile sheet will be clearly labeled on the right side so that any plan user can readily determine what special feature is shown.

Utility Sheets

All mainline utility sheets will be shown first, in the order of increasing stationing. The continuous stationing of the mainline utility sheets will not be interrupted by special sheets showing utility details on or near the mainline.

Special utility sheets showing greater detail on or near the mainline will follow the mainline utility sheets in the order they appear along the mainline.

Each special utility sheet will be clearly labeled on the right side so that any plan user can readily determine what area is shown.

For utility sheets showing considerable utility detail, the scale will be increased to show only 15 stations per sheet.

Utility sheets will show project right-of-way numbers and utility sheet numbers in the lower right corners of the sheets.

Sheet Names and Sequences

The sheet names listed below will be used. Tables of contents will correspond with this list. The sheets will be placed in the plans in the sequence shown below:

1. Title Sheet
2. Symbols and Abbreviations
3. Table of Contents
4. Notes
5. Typical Sections
6. Linear and Level Data
7. Bid Items
8. Details
9. Plan and Profile
10. Utilities
11. Standard Drawings
12. Bridge Plans and Quantities
13. Cross Sections

Orientation of Notes and Dimensions

All notes and all figures showing dimensions will be written horizontally from left to right, with these exceptions:

1. Pipe installation notes and equation notes on plan views of plan and profile sheets will be written vertically.

2. Full stations and elevations of points of intersection for vertical curves will be written vertically at the bottoms of profile views on plan and profile sheets.

3. If limited space for notes and dimensions make horizontal placement detrimental to the readability of the plans, they may be placed vertically. No notes or dimensions will be written from right to left in an inverted position.

Data to be Deleted from the Plans

The lists below summarize items no longer to be included in the contract plans.

1. Federal road division numbers, fiscal years and total sheets will be deleted from sheet identification boxes on all sheets.

2. Items to be deleted from title sheets:

   + Indices of sheets
   + Conventional signs legends
   + Project title notes describing locations of proposed roadways between county lines
   + State numbers and plans and contract completion dates

+ All project limits on the layout map except the limits of the project for which the plans are prepared

+ Names of interchanges, bridge materials and the beginning and ending stations of bridges on the layout map

3. Gravel sheets and borrow site maps will be deleted from the contract plans and placed in bid proposals.

4. Items to be deleted from typical section sheets:

+ Bases of plan quantities for surfacing materials on the main line

+ Plan quantities for gravel except "area in square feet" and "tons per station"

+ Plan quantities for bitumen except "square yards per station" and "tons per station"

+ Station limits other than those within which typical sections apply

+ General notes referring to slope details on cross sections and standard drawings, and

+ Rates of transverse surface slopes on finished shoulders.

5. Items to be deleted from quantity summaries:

+ Descriptions of items to be removed by non-contractor personnel

+ Descriptions of work procedures to be used by contractors

+ Items of work or materials which are not bid items

+ Summaries of project lengths

+ Straight line diagrams

+ Typical-section-for-grading frames
+ Additional excavation frames
+ Sketches, diagrams and drawings
+ Culvert and irrigation structure requirements at individual stations
+ All other items except summaries of bid items

6. All data except detail type, station and scale will be deleted from the identification box on detail sheets.

7. Items to be deleted from plan and profile sheets:

+ Notes indicating items to be removed by non-contractor personnel
+ Instructions for interpreting the plans, such as "R/W line = control of access unless otherwise noted"
+ Sources of bearing data
+ Sources of bench mark data
+ Bench mark data
+ Stations at which right-of-way widths change
+ Notes describing overhead utilities
+ Circles around utility poles within construction limits
+ Tangent lines and P.I. dots for all vertical curves
+ Names of the owners of existing signs
+ Data showing specific relationships between locations of the section lines and corners and the proposed roadway
+ Station limits within which specific typical sections apply

+ Data describing bench marks placed by the United States Coast and Geodetic Survey, except "U.S.C. & G.S. B.M."
+ Borrow site maps
+ Guard rail symbols in the plan view

8. Items to be deleted from utility sheets:
   + Federal road district numbers
   + State numbers
   + "State of Montana: State Highway Commission"

Data to be Included in the Plans

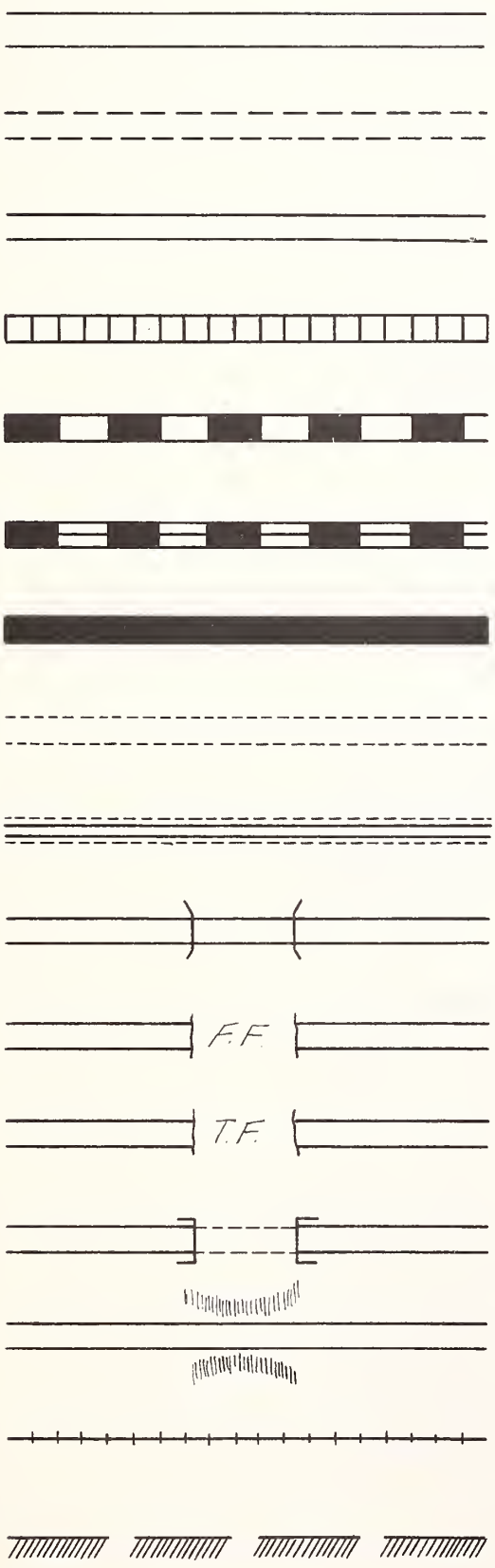
The following list summarizes items to be added to the contract plans.

1. State-optioned borrow sources will be shown on the layout map on the title sheet.
2. The heading "Design Data" will identify those design data required on the title sheet by the Bureau of Public Roads.
3. "Letting Date _____" will appear under the sheet identification box on the title sheet.
4. Rates of full superelevation will be shown with all horizontal curve data on plan and profile sheets.
5. Signs shown on plan and profile sheets will be labeled "sign."
6. The full station and elevation of each vertical curve point of intersection will be written vertically at the bottom of the profile on plan and profile sheets.
7. Right-of-way limits will be shown on cross section sheets.

EXAMPLE EXHIBIT 1

STANDARD SYMBOLS

TITLE SHEET



PRIMARY ROAD*

PRIMITIVE ROAD

UNIMPROVED ROAD

GRADED ROAD

GRAVELED ROAD

OILED ROAD

PAVED ROAD (Brick or Concrete)

FEDERAL AID ROUTING (Non-existent Road)

FEDERAL AID ROUTING (On Existing Road)

BRIDGE

FREE FERRY

TOLL FERRY

HIGHWAY TUNNEL

PASS

RAILROAD

RESERVATION LINE

* Primary roads are .08 inch wide. All others are .05 inch wide.

EXAMPLE EXHIBIT 2

STANDARD ABBREVIATIONS

Add. Exc.	Additional Excavation
Ah.	Ahead
App.	Approach
Approx.	Approximate
Av.	Average
Beg.	Begin
B. E.	Bridge End
Bit.	Bituminous or Bitumen
Bk.	Back or Bank
Bldg.	Building
Blk.	Block
B. M.	Bench Mark
Bot.	Bottom
Br.	Bridge
C	Cut
C & G	Curb & Gutter
C/A	Control of Access
C.A.P.	Corrugated Aluminum Pipe
Ch.	Channel
Ch. Ch.	Channel Change
Cl.	Class
Co.	County
Comp.	Compaction
Conc.	Concrete
Conn.	Connection
Const.	Construction
Cor.	Corner
Cov.	Cover
Cr.	Crushed
Crs.	Course
C. S.	Curve to Spiral
C. S. P.	Corrugated Steel Pipe

ROAD DESIGN
MODEL SYSTEM

Included in this section of the appendix is information which provides road design personnel with guidance in the road design work system. Information on the step-by-step process of road design is presented in three ways:

1. Procedures -- narrative explanations of the actions required in the design process and the personnel responsible for accomplishing the work.

2. Work flow diagrams -- graphic descriptions of the work to be done, the relationships between activities and the sequences of activities.

3. Check sheets -- guidelines for ensuring that the quality of design is adequate and accurate. The check sheets will be used in preparing both the preliminary (P.P.I.H.) and final (F.P.I.H.) plans. The check sheets should become a permanent part of each project file.

PROCEDURE

DESIGN AND DEVELOPMENT
OF CONTRACT PLANS

Date Issued

AUTHORITY: This procedure has been prepared by the Chief, Bureau of Road Design, reviewed by the Administrator, Preconstruction Division, and approved by the State Highway Engineer.

PURPOSE: To establish the procedure for road design and development of contract plans from the time the field survey and related data are received in the Bureau of Road Design through the date of transmitting the contract plans, special provisions and design file to the Contract Plans Unit.

PROCEDURE:

Responsibility	Action
District Engineer and District Right-of-Way Supervisor	1. Transmits the following information on or before the scheduled date to the Bureau of Road Design. a. Hardshell b. Design map c. Soils profile d. Topsoil availability form e. Shrinkage factor recommendations f. Local water data and/or geologist recommendations g. Existing drainage and recommendations h. Irrigation and access recommendations i. Telephone and electrical service information j. Recommended grade line k. Narrow-band ownership map l. Survey notes m. Percolation test information
Project Supervisor	2. Transmits the field drainage recommendations for major drainage installations to the Hydraulics Unit and requests drainage recommendations by a specific date.
	3. Transmits the Bridge Situation Sheets, survey notes and other data pertinent to bridge design to the Bureau of Bridge Design.
	4. Transmits sketch map and requests traffic data on the project by a specific date from the Bureau of Planning Survey.

Responsibility		Action
Project Supervisor	5.	Transmits existing data on special soils or materials and requests recommendations by a specific date from the Bureau of Materials.
	6.	Transmits pertinent data and requests cost estimates on special problems by a specific date from the Bureau of Right-of-Way.
Project and Senior Supervisor	7.	Conduct a field review of the project, if the terrain and project conditions dictate.
Project Supervisor	8.	Assigns crew to check survey notes and develops title sheet master.
	9.	Requests the Tracing Crew to trace the hardshell data onto linens by a specific date.
Crew leader, Tracing Crew	10.	Completes hardshell tracing and transmits linens to the design crew on or before the scheduled date.
Project Supervisor	11.	Requests, receives and verifies the ground line reduction printout, and checks linens against survey notes.
Project and Senior Supervisor	12.	Develop a draft Planning Report including the following design criteria for the mainline, land service features and other special features of a project, as appropriate: a. Traffic characteristics b. Design speed c. Maximum degree of curvature d. Staked and projected centerline characteristics e. Slope design f. Ditch widths g. Typical section characteristics h. Location of special features i. Existing utility services j. Description of anticipated special features k. Summary of available special studies data including soils exploration, geology, and water reports. l. Preliminary rights-of-way considerations m. Major hydraulic considerations.

Responsibility		Action
Project and Senior Supervisors	13.	Transmit copies and request comments on the draft Planning Report by a specific date from the following: a. Administrator, Preconstruction Division b. Federal Highway Administration c. District Engineer d. Chief, Bureau of Road Design e. Location and Road Design Supervisor f. Engineering Services Supervisor g. Other parties affected by the project
Senior Supervisor	14.	Coordinates and acts on any comments received and requests Department approval of the final Planning Report from the Administrator, Preconstruction Division.
Administrator, Preconstruction Division	15.	Reviews and approves the Planning Report
Project Supervisor	16.	Receives notice of Planning Report approval.
	17.	Transmits the linens to the Right-of-Way Crew for preparation of the first brownline for the Bureau of Right-of-Way.
Crew Leader, Right-of-Way Crew	18.	Plots the ownership information and transmits a brownline print to the Bureau of Right-of-Way.
Project Supervisor	19.	Transmits project characteristics, as shown in the Planning Report, and requests airport clearance from the Federal Avaiation Administration via the Federal Highway Administration by a specific date.
	20.	Requests the receipt of approved structural sections for a project by a specific date from the Surfacing Unit.
	21.	Requests the receipt of estimates for I.G. splits from the Bureau of Right-of-Way by a specific date.

Responsibility		Action
Project Supervisor	22.	Initiates design and assigns personnel to perform the following preliminary design: a. Establishes major control points b. Establishes preliminary plan and profile for any special features. c. Establishes preliminary grade and alignment of the mainline. d. Accomplishes preliminary earth runs on the project to achieve near optimum grade and alignment. e. Establishes the preliminary typical sections based on approved structural sections.
	23.	Requests aid from the Geometric Crew in the Traffic Unit on special traffic considerations for any special features.
	24.	Transmits the geometrics data for special feature design to the Federal Highway Administration and request comments by a specific date.
	25.	Transmits the proposed grade line and preliminary typical section to the Bureau of Bridge design and requests the receipt of preliminary bridge ends by a specific date.
	26.	Prepares the plans and related information for the preliminary plan-in-hand inspection including the following: a. Cross sections plotted to one-half scale. b. Typical sections of mainline and special features. c. Mass diagram d. Preliminary special provisions e. Preliminary plan and profile sheets f. Proposed access features g. Preliminary grading frame h. Title sheet i. Preliminary linear data frame j. Preliminary geometric layouts of special features
	27.	Develops and transmits the Fish and Game form and the Parks and Recreation form to the appropriate agency.

Responsibility		Action
Senior Supervisor	28.	Develops the cover letter setting the proposed date for the preliminary plan-in-hand and distributes prints of plans and information to the following: a. Federal Highway Administration b. District Engineer c. Division Engineer d. District Right-of-Way representative e. Other affected public agencies
Senior and Project Supervisors	29.	Conduct the office and field review of the preliminary plan-in-hand plans and obtain decisions on the following items in sufficient detail to prepare final plans: a. Alignment b. Grade c. Typical section d. Ditch widths e. Backslope design f. Shrink and/or swell factors g. Grading quantities h. Borrow pit locations i. Special treatments for sub-excavation, surcharge, underdrains, and unusual materials or soils conditions. j. Location and geometric layout for special features. k. Separations l. Location, grade, alignment and typical sections for frontage roads. m. Major irrigation features n. Major land service features o. Construction traffic p. Gravel sources q. Connection to P.T.W. r. Construction and right-of-way project length characteristics s. Layout of structures t. I.G. splits u. Average bid prices for grading, drainage, surfacing, guardrail, and right-of-way estimate. v. Approach surfacing depths w. Types of material to be used for guardrail, guardrail posts, pipes, culverts, and fences.

Responsibility		Action
Project Supervisor	30.	Identifies the need, provides relevant data and requests special studies to be conducted by a specific date by any one or combination of the following: a. Design Consultant b. Bureau of Right-of-Way c. Bureau of Materials d. Bureau of Bridge Design e. Traffic Unit f. District g. Hydraulics Unit h. Public Agency
Project and Senior Supervisors	31.	Receive pertinent data, develop potential solutions to major problems and obtain Department approval from the Chief, Bureau of Road Design.
	32.	Obtain a Department decision on minor problems from the Supervisor, Location and Road Design.
	33.	Prepare the Preliminary Plan-In-Hand Report documenting decisions and considerations made during the preliminary plan-in-hand inspection.
	34.	Distribute the Preliminary Plan-In-Hand Report and request comments by a specific date from the following: a. Federal Highway Administration b. Chief, Bureau of Road Design c. District Engineer d. Division Engineer e. District Right-of-Way Supervisor f. Other affected public agencies.
	35.	Receive comments on the content of the Preliminary Plan-In-Hand Report, ammend the report as required and redistribute.
Project Supervisor	36.	Requests additional borrow and materials site information, if required, by a specific date from the District.

Responsibility		Action
Project Supervisor	37.	Requests the Bureau of Right-of-Way to option required pits.
	38.	Updates the Parks and Recreation form and Fish and Game form data and transmits copies to the appropriate agency requesting comments by a specific date.
	39.	Requests the landscape and beautification layouts by a specific date from the Environmental Unit.
	40.	Develops and transmits a project costs estimate -- based on the average bid prices developed during the preliminary plan-in-hand inspection -- to the Project Control Section.
	41.	Initiates the development of the public hearing displays.
Project and Senior Supervisors	42.	Prepare the environmental statement, if required. (See the procedure for the Development of the Environmental Statement).
	43.	Receive notice of Department approval of the environmental statement.
Project Supervisor	44.	Initiates final design and assigns personnel to perform the following design, as required: a. Plot and template remaining cross sections. b. Tie geometrics of mainline and special features. c. Establish final grade and alignment of the mainline and special features. d. Contour grading e. Field entrance design f. Road approach design g. Final earth runs on the project based on alignment and grade. h. Mass diagram of project. i. Special provisions associated with the above design.
	45.	Transmits construction prints to the Right-of-Way crew for the updating of ownership data.

Responsibility		Action
Project Supervisor	46.	Requests the receipt of a bridge layout by a specific date from the Bureau of Bridge Design.
	47.	Transmits construction prints and requests the receipt of signing and electrical plans, as required, by a specific date from the Traffic Unit.
	48.	Receives requests for modifications made to construction plans for turn lanes and other physical features required for traffic maintenance and safety from the Traffic Unit.
	49.	Accomplishes the alterations of the construction plans, as required.
	50.	Initiates the design of miscellaneous features and assigns personnel to perform the following as required: a. Develop Linear and Level Data sheet. b. Determine topsoil requirements c. Seed and mulch design d. Retaining wall (standard) design e. Removal and reset features design f. Adjustments to grade design g. Sidewalk design h. Curb and gutter design i. Concrete slope protection design j. Guardrail design k. Embankment protector design l. Bituminous curb design m. Cattle guard design n. Culvert and irrigation design o. Ditch block design p. Project markers and monuments design q. Plot topography on cross sections r. Plot construction limits on right-of-way linens.
	51.	Transmits right-of-way linens to the Right-of-Way crew for the design of right-of-way limits, development of right-of-way plans, calculations of areas of take and preparation of utility plans.
	52.	Requests that the Public Hearing Unit advertise for and conduct the Design Public Hearing on or before a specific date. (see step 42)

PROCEDURE

DESIGN AND DEVELOPMENT
OF CONTRACT PLANS

Date Issued

Responsibility		Action
Senior Supervisor	53.	Develops a draft Design Study Report documenting the significant features and criteria used in the design of the project including: a. Design standards b. Geometrics of the mainline, access features and other special features. c. Characteristics of project structures d. Rights-of-way needs e. Summary and analysis of the Design Public Hearing. f. Reference to the environmental statement, if required.
	54.	Transmits copies and requests comments on the draft Design Study Report by a specific date from the following: a. Administrator, Preconstruction Division b. Federal Highway Administration c. District Engineer d. Chief, Bureau of Road Design e. Location and Road Design Supervisor f. Engineering Services Supervisor g. Other parties affected by the project.
	55.	Coordinates and acts on any comments received and requests Department approval of the final Design Study Report from the Administrator, Preconstruction Division.
Administrator, Preconstruction Division	56.	Reviews and approves the Design Study Report
Senior Supervisor	57.	Transmits the Department approved Design Study Report to the Federal Highway Administration and requests approval.
	58.	Receives notice of Design Study Report approval.

Responsibility		Action
Senior Supervisor	59.	Transmits copies of the approved Design Study Report to the following: a. Administrator, Preconstruction Division b. District Engineer c. Chief, Bureau of Road Design d. Location and Road Design Supervisor e. Engineering Services Supervisor f. Other parties affected by the project.
Project Supervisor	60.	Requests the Public Hearings Unit to advertise the notice of approval in the media.
	61.	Prepares the plans and related information for the final plan-in-hand inspection including the following items: a. Plan and profile sheets b. Title sheet c. Materials quantities and summary frames d. Typical sections e. General notes sheet f. Tentative table of contents g. Linear and level data sheet h. Detail sheets
Senior Supervisor	62.	Develops the cover letter setting the proposed date for the final plan-in-hand and distributes prints of plans and information to the following personnel: a. Federal Highway Administration b. District Engineer c. Division Engineer d. District Right-of-Way representative e. Other affected public agencies.

Responsibility		Action
Senior and Project Supervisors	63.	Conduct the office and field reviews of the final plan-in-hand plans and obtain decisions on the following items: a. Drainage b. Guardrail c. Fencing d. Final right-of-way widths e. Irrigation facilities f. Slope protection g. Top soiling h. Channel change i. Riprap j. Special provisions k. Seeding and mulch l. Other miscellaneous design features
Project Supervisor	64.	Identifies the need, provides relevant data and requests special studies to be conducted by a specific date by any one or combination of the following: a. Design consultant b. Bureau of Right-of-Way c. Bureau of Materials d. Bureau of Bridge Design e. Traffic Unit f. District Personnel g. Hydraulics Unit h. Public Agency
Project and Senior Supervisors	65.	Receive the pertinent data, determine the potential solution to the problem and obtain Department approval for solutions to major problems from the Chief, Bureau of Road Design.
	66.	Obtain Department decisions on solutions for minor problems from the Supervisor, Location and Road Design.
	67.	Prepare the final Plan-In-Hand Report documenting decisions and considerations made during the final Plan-In-Hand Inspection.

Responsibility		Action
Project and Senior Supervisors	68.	Distribute the Final Plan-In-Hand Report and request comments by a specific date from the following: a. Federal Highway Administration b. Chief, Bureau of Road Design c. District Engineer d. Division Engineer e. District Right-of-Way Supervisor f. Other affected public agencies.
	69.	Receive comments on the content of the Final Plan-In-Hand Report, ammend the report as required and redistribute.
Project Supervisor	70.	Receives the unit price estimate from the District Engineer and prepares the final cost estimate.
	71.	Transmits the cost estimate to the Project Control Section.
	72.	Updates and revises control of access feature, construction limits and irrigation design.
	73.	Transmits construction plans to the Right-of-Way crew for modification of right-of-way plans, utility plans and the preparation of fencing plans.
	74.	Updates and revises special provisions, and miscellaneous design as required by acquisition agreements and requests from the Bureau of Right-of-Way.
	75.	Requests the final tracing and inking of the contract plans by a specific date from the Tracing crew.
Crew Leader, Tracing Crew	76.	Completes the tracing and inking of contract plans within the scheduled dates.
Project Supervisor	77.	Checks the plans for adequacy and accuracy.
	78.	Transmits the contract plans, cross sections, special provision and project file to the checker and requests final checking to be accomplished by a specific date.

Responsibility		Action
Checker	79.	Reviews and checks the project design, contract plans and associated data.
Project Supervisor	80.	Modifies and changes the contract plans, cross sections, and special provisions as required.
	81.	Transmits the contract plans and associated data to the Contract Plans Unit.

WORK FLOW

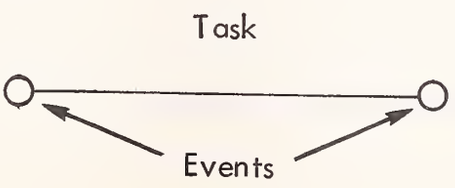
There are four flow chart symbols. These are the symbols for an event, a task or activity, a connector and a restraint. The way these symbols are arranged show relationships between tasks or activities and events.

Events

Events are points in time. In the flow charts shown in this appendix, they are shown as small circles. Examples of events are completed field surveys, completed preliminary plan-in-hand inspections, starting alignment and grade design and starting rights-of-way design. Notice that an event is the start or the completion of tasks or activities.

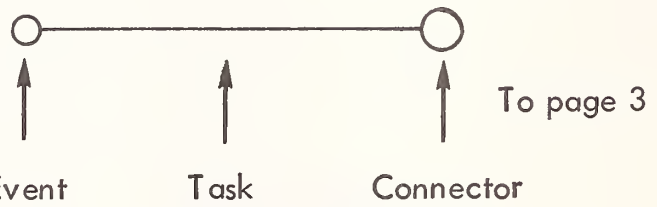
Tasks (Activities)

Tasks consume time and money, and unlike events they span a period of time. Examples of tasks are perform field surveys, conduct preliminary plan-in-hand inspections, design alignment and grade, and design rights-of-way limits. Tasks are always started by an event and completed by an event.



Connector

A connector, in the charts used in the appendix, is used when the chart is continued on another page. This symbol is used in this manner:



Connectors will be numbered or carry a letter within the connector symbol. Near the connector there will also be a page number showing where the flow is continued.

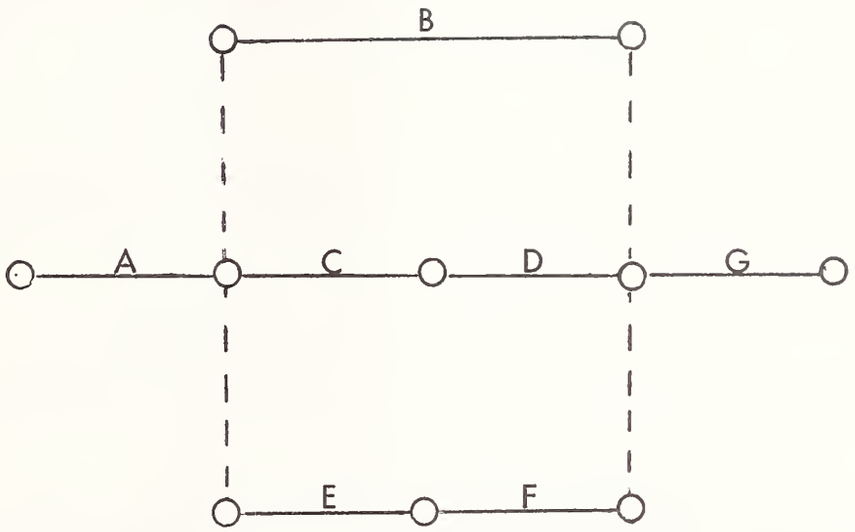
Restraints

A restraint is shown as a dotted line. It will always connect events, and it will normally run up and down, like this:

Restraints show relationships between events.

Workflow Interpretation

Review the following chart:



This chart says that:

1. Activities "B", "C" and "E" may not be started until "A" has been completed.

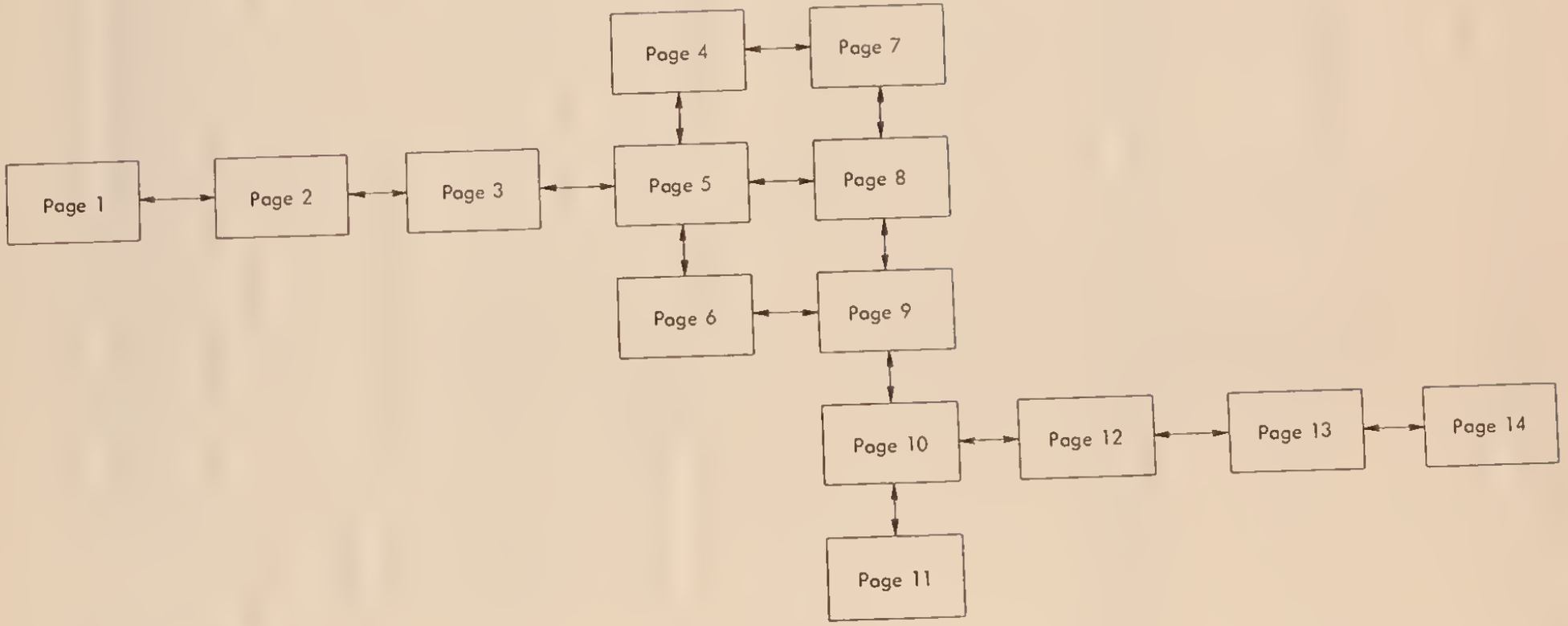
2. Activities "D" and "F" may proceed independently from "B", but "D" may not start until "C" is complete and "F" may not start until "E" is complete.

3. Activity "G" may not commence until "B", "D" and "F" are complete.

The work flow shown on the following pages is not meant to cover all design situations, but rather to provide general guidance for normal projects. Very few projects will require the accomplishment of all 240 work items in the flow diagram. (The skeleton flow for some specialized work sequences -- such as Traffic -- is included to indicate how these activities relate to design activities.)

PAGE REFERENCE CHART

FOR FLOW DIAGRAM SEGMENTS



From receipt of field survey
To completion of P.P.I.H. Report

From completion of P.P.I.H. Report
To completion of miscellaneous design

From completion of miscellaneous design
to transmit plans package to Contract Plans Unit

RECEIVE THE FOLLOWING:

1 HARDSHELL
2 DESIGN MAP (AERIAL)
3 SOILS PROFILE
4 TOPSOIL RVAIL FORM
5 SHRINKAGE FACTOR RECOMMENDATIONS
6 LOCAL WATER DATA AND/OR GEOLOGIST RECOMMENDATIONS
7 EXISTING DRAINAGE AND RECOMM
8 IRRIGATION AND ACCESS RECOMM
9 TELEPHONE AND ELECTRICAL SERVICES INFORMATION
10 RECOMM GRADE LINE
11 NARROW-BAND OWNERSHIP MAP
12 SURVEY NOTES
13 PERCOLATION TEST

REQUEST DRAINAGE RECOMMENDATIONS FOR MAJOR DRAINAGE FROM HYDRAULICS UNIT

RECEIVE DRAINAGE RECOMMENDATIONS FROM HYDRAULICS UNIT

TO PAGE 2 (1)

REQUEST DATA ON SPECIAL SOILS OR MATERIALS FROM BUREAU OF MATERIALS

RECEIVE DATA AND RECOMMENDATIONS FROM BUREAU OF MATERIALS

TRANSMIT SKETCH MAP TO PLANNING SURVEY AND REQUEST TRAFFIC DATA

RECEIVE TRAFFIC DATA FOR CROSS ROADS, MAINLINE AND FRONTAGE ROADS

REQUEST COST EST ON PROBLEMS FROM THE BUREAU OF RIGHT OF WAY

RECEIVE COST ESTIMATE FROM THE BUREAU OF RIGHT OF WAY

ASSEMBLE DATA AND WRITE DRAFT OF PLANNING REPORT

DISTRIBUTE THE PLANNING REPORT

RESOLVE PROBLEMS AND WRITE FINAL PLANNING REPORT

FIELD REVIEW BY AREA ENGINEER AND DESIGNER, IF TERRAIN AND CONDITIONS DICTATE

CHECK SURVEY NOTES FOR ACCURACY AND ADEQUACY

REQUEST PUNCHING OF NOTES AND GROUND LINE REDUCTION RUN

VERIFY PUNCHED CARDS FOR DISTANCES AND ELEVATIONS OF CROSS SECTIONS

RECEIVE GROUND LINE ELEVATION REDUCTION PRINTOUT FROM O P

TRACE HARDSHELL DATA ONTO LINENS

CHECK LINENS AGAINST SURVEY NOTES

TRANSMIT BRIDGE SITUATION DATA TO BUREAU OF BRIDGE

DEVELOP TITLE SHEET MASTER

REQUEST AID FROM GEOMETRIC CREW ON SPECIAL TRAFFIC CONSIDERATIONS

DESIGN PLAN AND PROFILE FOR INTERCHANGES AND OTHER SPECIAL FEATURES

TRANSMIT GEOMETRIC DATA TO FHWA FOR COMMENTS

RECEIVE COMMENTS AND REVISE AS NECESSARY

TO PAGE 2 (2)

REQUEST THE STRUCTURAL SECTION FROM THE BUREAU OF MATERIALS

RECEIVE THE PRELIMINARY STRUCTURAL SECTION

RECEIVE COMMENTS AND REVISE AS NECESSARY

TO PAGE 2 (3)

REQUEST AIRPORT CLEARANCE FROM THE F A A VIA THE FHWA

REQUEST ADDITIONAL SURVEY DATA, IF REQUIRED BY PROJECTION

RECEIVE SURVEY INFORMATION, IF REQUIRED

REQUEST "HALO" RUN FOR EQUIVALENT STATIONING AND HORIZONTAL OFFSET

RECEIVE "HALO" RUN AND VERIFY FOR ACCURACY

REQUEST LINE SHIFT AND GROUND LINE ELEVATION REDUCTION RUN

RECEIVE COMPUTER PRINTOUTS OF PROJECTED GROUND LINE DATA

TO PAGE 2 (4)

IS THE CENTERLINE PROJECTED ?

YES

NO

ESTABLISH MAJOR CONTROL POINTS FOR PROJECT

HAND PLOT GROUND LINE FOR SELECTED CROSS SECTIONS

TEMPLATE CROSS SECTIONS CONTROLLING GRADE, ALIGNMENT OR HYDRAULICS

TO PAGE 2 (5)

REQUEST RIGHT OF WAY ESTIMATE FOR ECONOMIC ANALYSIS OF IG-SPLITS

TO PAGE 2 (6)

PREPARE RIGHT OF WAY MASTERS FROM LINENS

DRAFT OWNERSHIP INFORMATION ON BROWN LINE PRINT

TO PAGE 2 (7)

FROM PAGE 1

PLOT PRELIMINARY PIPE INFORMATION FOR PPIH

FROM PAGE 2

FROM PAGE 3

RECEIVE NOTICE OF APPROVAL OF STRUCTURAL SECTION FROM FHWA

DESIGN THE MAINLINE AND OTHER NECESSARY TYPICAL SECTIONS

REQUEST COMPUTER PLOTTED CROSS SECTIONS TO ONE-HALF SCALE

RECEIVE ONE-HALF SCALE PLOTTED CROSS SECTIONS

DEVELOP DP INPUTS FOR FINAL EARTHWORK RUN

REQUEST AND RECEIVE COMPUTER EARTHWORK RUN

IS GRADE AND ALIGNMENT NEAR OPTIMUM ?

YES

NO

PREPARE ONE PAGE MASS DIAGRAM FOR PPIH

SUMMARIZE GRADING QUANTITIES ON MASS DIAGRAM

WRITE COVER LETTER FOR PPIH TO INDICATE TIME AND PLACE

YES

REPEAT IF NECESSARY

FROM PAGE 4

HAS DEPARTMENT RECVD STRUCTURAL SECT APPR ?

NO

DEVELOP DP INPUTS FOR PRELIMINARY EARTHWORK QUANTITY RUN

REQUEST AND RECEIVE PRELIMINARY EARTH-WORK QUANTITIES FROM DATA PROCESSING

DEVELOP PRELIMINARY SPECIAL PROV FOR SUB-EXCAVATION SURCHARGE, CONST TRAFFIC

CHECK PRELIMINARY PLANS FOR ADAQUACY

ESTABLISH DATE OF PPIH WITH DISTRICT AND FHWA

RECEIVE AND REC REPRODUCTIONS OF PPIH

DISTRIBUTE PRINTS FOR PPIH TO ALL INTERESTED PARTIES

CONDUCT OFFICE REVIEW OF PPIH PLANS IN FIELD

TO PAGE 3

8

FROM PAGE 5

TRANSMIT PROPOSED GRADE LINE AND TYPICAL SECTION TO BUREAU OF BRIDGE

REQUEST PRELIMINARY BRIDGE ENDS AND ANY CHANGES TO GRADE OR ALIGNMENT

RECEIVE PRELIMINARY BRIDGE ENDS AND CHANGES FROM BUREAU OF BRIDGE

PLOT PRELIMINARY GRADES ON LINENS

DEVELOP AND TRANSMIT FISH AND GAME FORM

FROM PAGE 6

DEVELOP ECONOMIC ANALYSIS OF IG SPLITS AND PROJECT LENGTH CHARACTERISTICS

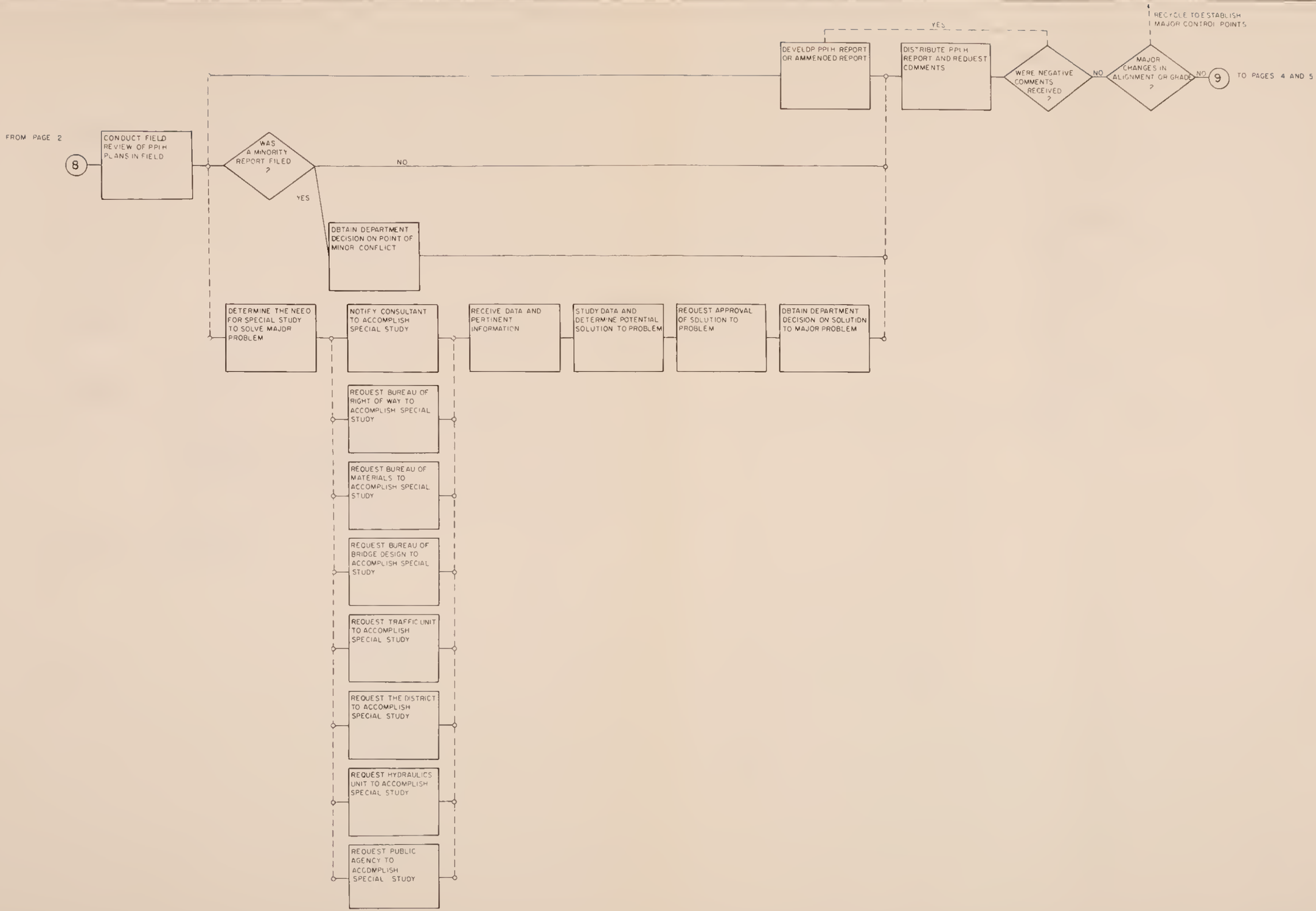
DEVELOP AND TRANSMIT PARKS AND RECREATION FORM

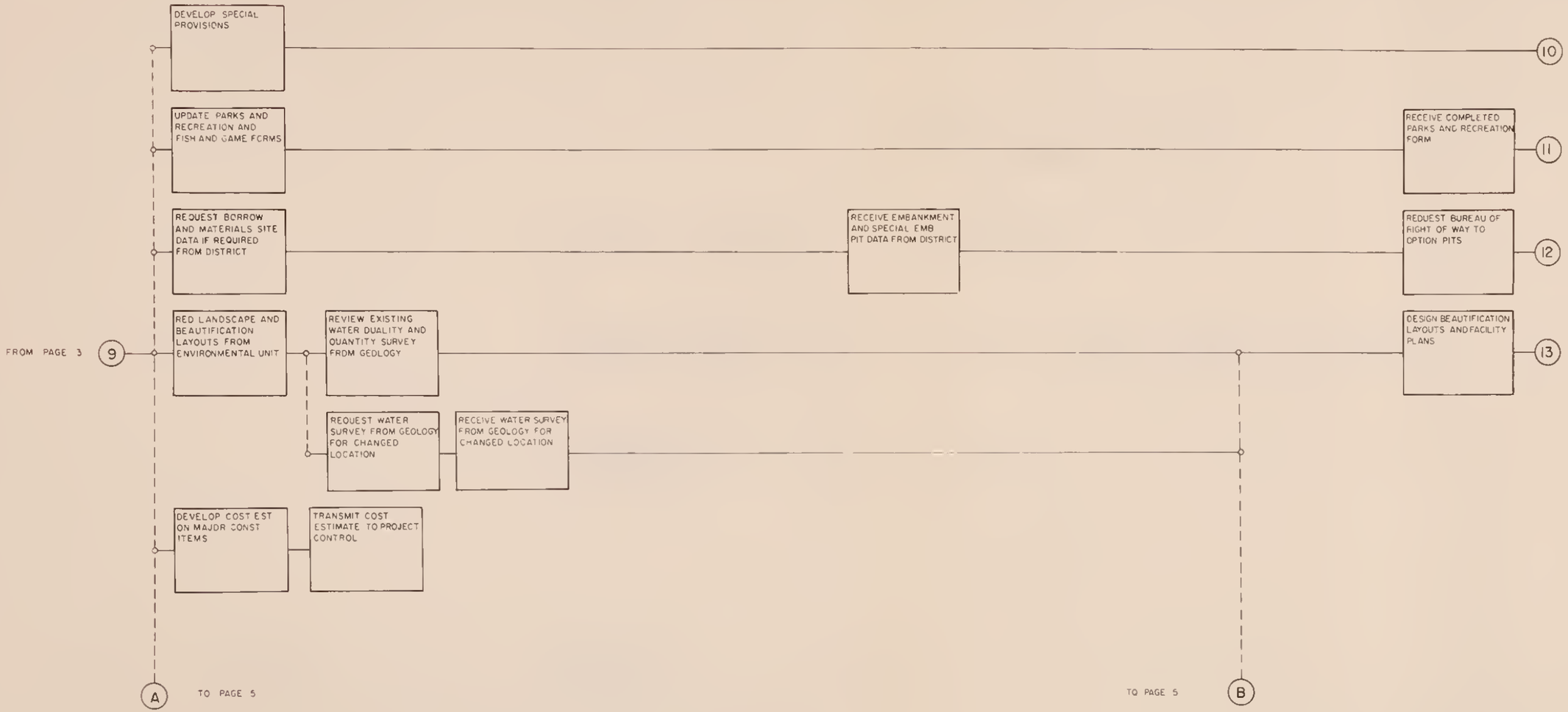
FROM PAGE 7

DEVELOP GENERAL LAYOUT OF STRUCTURE IN BUREAU OF BRIDGE

DEVELOP RECOMM FOR RIPRAP, CHANNEL CLEARING, EXCAVATING AND SPEC EMBANKMENT

TRANSMIT GENERAL LAYOUT AND RECOMM TO BUREAU OF ROAD DESIGN


FROM PAGE 2
8
CONDUCT FIELD REVIEW OF PPIH PLANS IN FIELD
WAS A MINORITY REPORT FILED ?
NO
YES
OBTAIN DEPARTMENT DECISION ON POINT OF MINOR CONFLICT
DETERMINE THE NEED FOR SPECIAL STUDY TO SOLVE MAJOR PROBLEM
NOTIFY CONSULTANT TO ACCOMPLISH SPECIAL STUDY
RECEIVE DATA AND PERTINENT INFORMATION
STUDY DATA AND DETERMINE POTENTIAL SOLUTION TO PROBLEM
REQUEST APPROVAL OF SOLUTION TO PROBLEM
OBTAIN DEPARTMENT DECISION ON SOLUTION TO MAJOR PROBLEM
REQUEST BUREAU OF RIGHT OF WAY TO ACCOMPLISH SPECIAL STUDY
REQUEST BUREAU OF MATERIALS TO ACCOMPLISH SPECIAL STUDY
REQUEST BUREAU OF BRIDGE DESIGN TO ACCOMPLISH SPECIAL STUDY
REQUEST TRAFFIC UNIT TO ACCOMPLISH SPECIAL STUDY
REQUEST THE DISTRICT TO ACCOMPLISH SPECIAL STUDY
REQUEST HYDRAULICS UNIT TO ACCOMPLISH SPECIAL STUDY
REQUEST PUBLIC AGENCY TO ACCOMPLISH SPECIAL STUDY
DEVELOP PPIH REPORT OR AMMENDED REPORT
YES
DISTRIBUTE PPIH REPORT AND REQUEST COMMENTS
WERE NEGATIVE COMMENTS RECEIVED ?
NO
MAJOR CHANGES IN ALIGNMENT OR GRADE ?
NO
RECYCLE TO ESTABLISH MAJOR CONTROL POINTS
9
TO PAGES 4 AND 5


DEVELOP SPECIAL PROVISIONS
10
UPDATE PARKS AND RECREATION AND FISH AND GAME FORMS
RECEIVE COMPLETED PARKS AND RECREATION FORM
11
REQUEST BORROW AND MATERIALS SITE DATA IF REQUIRED FROM DISTRICT
RECEIVE EMBANKMENT AND SPECIAL EMB PIT DATA FROM DISTRICT
REQUEST BUREAU OF RIGHT OF WAY TO OPTION PITS
12
FROM PAGE 3
9
RED LANDSCAPE AND BEAUTIFICATION LAYOUTS FROM ENVIRONMENTAL UNIT
REVIEW EXISTING WATER DUALITY AND QUANTITY SURVEY FROM GEOLOGY
DESIGN BEAUTIFICATION LAYOUTS AND FACILITY PLANS
13
REQUEST WATER SURVEY FROM GEOLOGY FOR CHANGED LOCATION
RECEIVE WATER SURVEY FROM GEOLOGY FOR CHANGED LOCATION
DEVELOP COST EST ON MAJOR CONST ITEMS
TRANSMIT COST ESTIMATE TO PROJECT CONTROL
A
TO PAGE 5
TO PAGE 5
B

FROM PAGE 4

(A)

DEVELOP PUBLIC HEARING DISPLAY

DEVELOP ENVIRONMENTAL STATEMENT IF NECESSARY

PLOT REMAINING OR ADDITIONAL CROSS SECTIONS

TEMPLATE CROSS SECTIONS

FROM PAGE 4

(B)

TO PAGE 8

(14)

REQUEST ADDITIONAL DATA ON OWNERSHIP

RECEIVE ADDITIONAL OWNERSHIP DATA FROM DISTRICT

UP-DATE OWNERSHIP DATA ON PLANS

TRANSMIT CONST PRINTS TO RIGHT-OF-WAY CREW

PRODUCE ALIGNMENT OF ALL FEATURES BY RIGHT-OF-WAY CREW

OBTAINS RIGHT-OF-WAY LINENS FROM RIGHT-OF-WAY CREW

REVIEW RIGHT-OF WAY RECOMMENDATIONS FOR FIELD ENTRANCES IF REQUIRED

DETERMINE LOCATION BASED ON SIGHT DIST AND MAIN_LINE ALIGN AND GRADE

DETERMINE APPROACH GRADE

DETERMINE LENGTH OF APPROACH

DETERMINE IF A CONSTRUCTION PERMIT IS NECESSARY

DETERMINE THE TURNING RADIUS OF APPROACH

WRITE NOTE OF APPROACH DATA ON CROSS SECTIONS

DETERMINE LOCATION OF ROAD APPROACHES BASED ON SIGHT DIST AND MAINLINE ALIGN AND GRADE

DETERMINE APPROACH GRADE

DETERMINE LENGTH OF APPROACH

DETERMINE THE TURNING RADIUS OF APPROACH

REVIEW MAJOR LAYOUT WITH TRAFFIC UNIT

FROM PAGE 3

(9)

TIE GEOM OF SPECIAL FEATURE TO ALIGNMENT AND GRADE OF MAINLINE

COMPUTE QUANTITIES BY HAND FOR SPECIAL FEATURES OR LARGE ADDITIONAL EXCAVATION

ESTABLISH MAJOR CONTROL POINTS OF MAINLINE AND SPECIAL FEATURES

REQUEST "HALO" RUN FOR EQUIV STA AND HORIZ. OFFSET FROM O.P

RECEIVE "HALO" RUN AND VERIFY ACCURACY

DETERMINE CONTROLLING CONTOUR ELEVATIONS

DETERMINE TWO FOOT CONTOUR ELEVATIONS BASED ON ESTHETICS AND ECONOMICS

BALANCE PROJECT CONSIDERING THE ADD. QUANTITIES OF SPECIAL FEATURES

ADJUST GRADE OF MAINLINE TO BALANCE WITH ECONOMIC HAUL

PREPARE ONE PAGE MASS DIAGRAM TO SHOW HAUL

TO PAGES 8, 9, 10, AND 11

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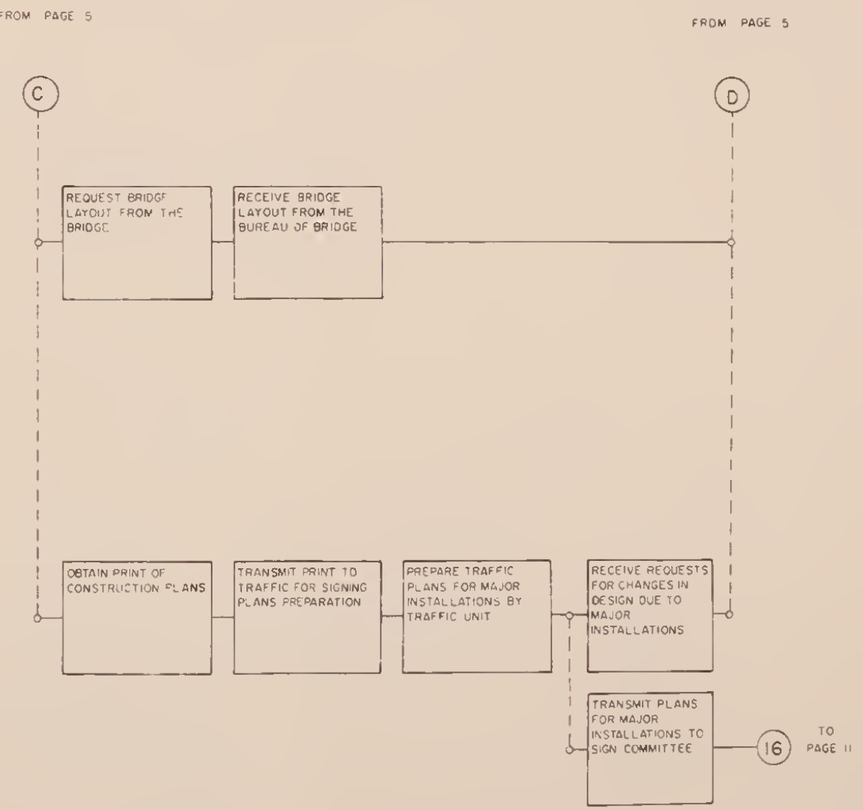
(C) TO PAGE 6

TO PAGE 6 (D)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C
REQUEST BRIDGE LAYOUT FROM THE BRIDGE
RECEIVE BRIDGE LAYOUT FROM THE BUREAU OF BRIDGE
OBTAIN PRINT OF CONSTRUCTION PLANS
TRANSMIT PRINT TO TRAFFIC FOR SIGNING PLANS PREPARATION
PREPARE TRAFFIC PLANS FOR MAJOR INSTALLATIONS BY TRAFFIC UNIT
RECEIVE REQUESTS FOR CHANGES IN DESIGN DUE TO MAJOR INSTALLATIONS
TRANSMIT PLANS FOR MAJOR INSTALLATIONS TO SIGN COMMITTEE
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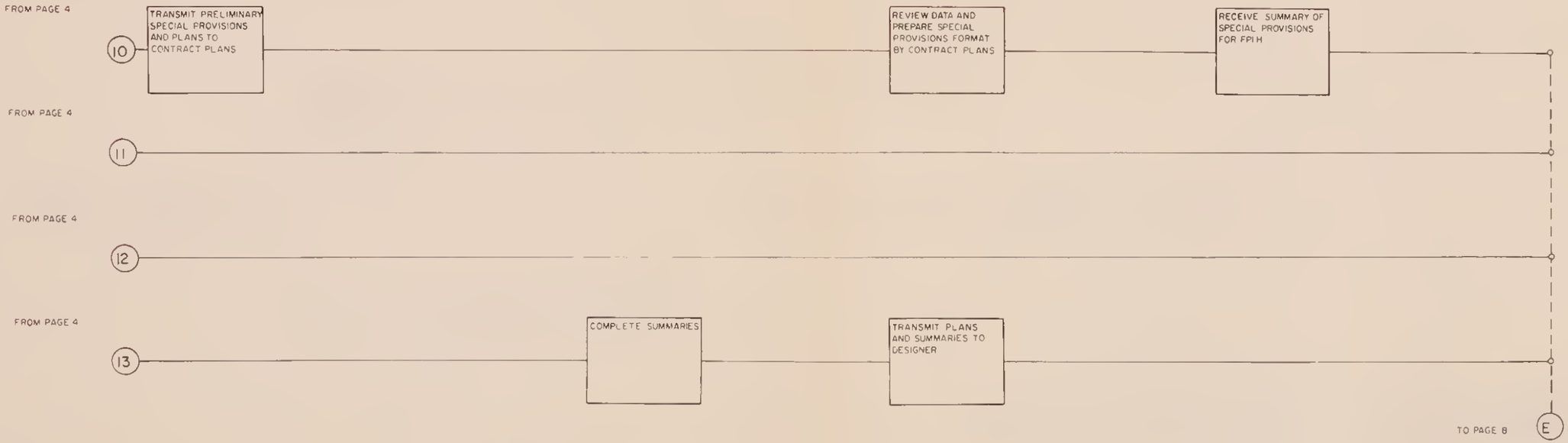
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TRANSMIT PRELIMINARY SPECIAL PROVISIONS AND PLANS TO CONTRACT PLANS
REVIEW DATA AND PREPARE SPECIAL PROVISIONS FORMAT BY CONTRACT PLANS
RECEIVE SUMMARY OF SPECIAL PROVISIONS FOR FPLH
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FROM PAGE 4
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13
COMPLETE SUMMARIES
TRANSMIT PLANS AND SUMMARIES TO DESIGNER
TO PAGE 8
E

FROM PAGE 5

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PLOT CONSTRUCTION LIMITS ON RIGHT-OF-WAY LINENS

TRANSMIT RIGHT-OF-WAY LINENS TO RIGHT-OF-WAY CREW

PLOT MAJOR TOPOGRAPHY ON CROSS SECTIONS

DESIGN RIGHT OF WAY LIMITS AND CONSTRUCTION PERMITS BY RIGHT-OF-WAY CREW

OBTAIN BROWN LINE OF R/W LINENS

DESIGN PRELIMINARY R/W LIMITS BASED ON STD DISTANCE BY R/W CREW

PLOT STANDARD R/W LIMITS ON BROWN LINE

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TRANSMIT BROWN LINE PRINTS TO BUREAU OF RIGHT OF WAY

OBTAIN SETS OF RIGHT OF WAY PRINTS FROM RIGHT OF WAY CREW

DETERMINE LOCATION OF MARKERS AND MONUMENTS

PLOT LOCATION ON RIGHT OF WAY PRINTS

PREPARE PRELIMINARY BROWN LINE UTILITY PLANS BY RIGHT OF WAY CREW

SEND MAJOR UTILITY ITEMS TO UTILITY SECT FOR PRELIMINARY CONTACT

CALCULATE TAKING AREA

PREPARE PRINTS FOR EPTH

ADVERTISE FOR DESIGN PUBLIC HEARING

INSPECT DESIGN STUDY AREA

DEVELOP DESIGN STUDY REPORT OR AMMENDED REPORT

TRANSMIT REPORT TO FHWA AND DEPARTMENT PERSONNEL

ADVERTISE FOR APPROVAL NOTICE IN MEDIA

WERE NEGATIVE COMMENTS RECEIVED ?

NO

FOR MAJOR PROBLEMS RECYCLE TO ESTABLISH MAJOR POINTS

RECEIVE DESIGN STUDY REPORT APPROVAL FROM FHWA

ADVERTISE NOTICE OF APPROVAL IN MEDIA

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FROM PAGE 8
G

ESTIMATE FLOW LINE ELEVATIONS FOR PIPE DESIGN FROM CROSS SECTIONS

DETERMINE DRAINAGE AREA FOR PIPE

DETERMINE IF SMALL PIPE IS SKEWED OR RIGHT ANGLE TO CENTERLINE

ESTABLISH GRADE LINE OF PIPE

DETERMINE TYPE OF END SECTION TREATMENT, IF REQUIRED

DETERMINE CLASS, GAUGE AND LENGTH OF PIPE

DETERMINE DITCH BLOCK PLACEMENT

DESIGN DITCH BLOCK LOCATION AND QUANTITIES

DETERMINE IF LARGE PIPE IS SKEWED OR RIGHT ANGLE TO CENTERLINE

ESTABLISH GRADE LINE OF PIPE

DETERMINE TYPE OF END SECTION TREATMENT, IF REQUIRED

DESIGN BEDDING, CONC CUTOFF WALLS, EDGL PROT AND OR RIPRAP INSTALLATION

DETERMINE CLASS, GAUGE AND LENGTH OF PIPE

DETERMINE CULVERT EXCAVATION

PREPARE PIPE NOTE ON CROSS SECTION

PLOT NOTE ON PLAN AND PROFILE SHEET

PLOT HYDRAULICS DATA ON PROFILE, IF PIPE CARRIES OVER 500 C.F.S.

FROM PAGE 5 (15)

DETERMINE LOCATIONS OF CATTLE GUARD

DESIGN LENGTH OF SECTION BASED ON WIDTH OF TYPICAL SECTION

PLACE NOTE ON PLANS SHEETS

REVIEW DESIGN SPEED AND FUTURE ADT FOR GUARDRAIL DESIGN

DEVELOP WARRENT VALUE FOR GUARDRAIL

DETERMINE POINT VALUE FOR EACH AFFECTED STATION

PLOT WARRENT VALUE AND POINT VALUE BY STATION

DETERMINE LENGTH OF MAIN SECTION

DETERMINE LENGTH OF END SECTION

DETERMINE IF LOCATION IS WARRANTED BY MINIMUM LENGTH

PLOT STATION LIMITS AND NOTE ON PROFILE

DETERMINE ADD SURFACING FOR GUARDRAIL WIDENING

DETERMINE EMB PROTECTOR LOCATION PER STANDARD

DETERMINE LENGTH OF BITUMINOUS CURB

DESIGN EMBANKMENT PROTECTOR

WRITE NOTE ON CROSS SECTION

PLOT NOTE ON PLAN AND PROFILE

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TO PAGE 10

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DETERMINE LOCATION OF CONCRETE SLOPE PROTECTION BASED ON TRAFFIC

OBTAIN LAYOUT OF STRUCTURE

DETERMINE ELEVATION AND LENGTH OF PROTECTOR

DEVELOP MATERIAL QUANTITIES

PLACE NOTE ON CROSS SECTIONS

PLACE NOTE ON PROFILE

DETERMINE NEED FOR CURBING

DETERMINE LENGTH OF CURB

DETERMINE LOCATIONS OF LAY DOWN CURB

DESIGN CURB AND GUTTER PER STANDARD BY TYPE

PLACE NOTE ON PLAN AND PROFILE

DETERMINE NEED AND LOCATION FOR SIDEWALK

DESIGN 4" AND 6" SIDEWALK LOCATIONS

PLACE NOTE ON PLAN AND PROFILE

DETERMINE LOCATION OF FEATURE TO BE ADJUSTED TO GRADE

DETERMINE ELEV FOR EACH FEATURE

PLACE NOTE ON PLAN

DETERMINE LOCATIONS OF FEATURE TO BE REMOVED AND RESET

PLACE NOTE ON PLAN

DETERMINE JUSTIFICATION FOR RETAINING WALL

DETERMINE TYPE OF WALL METAL, WOOD OR CONCRETE WALL

ESTABLISH GRADE LINE FOR BASE OF WALL

TEMPLATE FEATURE ON CROSS SECTIONS

DETERMINE LOCATION AND HEIGHT OF WALL

DESIGN LAYOUT OF RETAINING WALL

COMPUTE BACKFILL RETAINER

COMPUTE QUANTITIES

PLACE NOTE ON CROSS SECTION

PLACE NOTE ON PLAN AND PROFILE

REQUEST BUREAU OF BRIDGE TO ACCOMPLISH SPECIAL DESIGN

RECEIVE DATA ON SPECIAL DESIGN OF RETAINING WALL

DETERMINE NEED AND AVAILABILITY OF TOPSOIL

IDENTIFY LOCATIONS OF SLOPES STEEPER THAN 1½:1

WILL AREAS BE WORKED BY COMPUTER ?

YES

NO

FILL OUT COMPUTER FORM AND REQUEST RUN

RECEIVE PRINTOUT OF ACREAGES AND CUBIC YARDS OF TOPSOIL

DETERMINE ACREAGES BY HAND

DETERMINE CUBIC YARDS OF TOPSOIL REQUIRED

COMPUTE ACREAGES AND CUBIC YARDS OF INCIDENTAL FEATURES

DETERMINE TYPE OF SEED AND MULCH PER STANDARD

REQUEST AID FROM ENVIRONMENTAL UNIT ON SPECIAL PROBLEMS

DETERMINE TYPE OF SEED AND MULCH PER STANDARD OR RECOMMENDATIONS

DETERMINE POUNDS OF SEED AND TONS OF MULCH

J

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I

DEVELOP OR UPDATE ALL QUANTITY SUMMARIES

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DEVELOP LINEAR AND LEVEL DATA SHEET

ARE SIGNS OR ELECTRICAL INST. REQUIRED ?

NO SIGN

ELECT

DETERMINE LOCATION OF STANDARD SIGNS

DESIGN GUIDE SIGNS

REQUEST DESIGN OF SPECIAL SIGN SUPPORTS FROM BUREAU OF BRIDGE

RECEIVE SPECIAL SIGN SUPPORTS FROM BUREAU OF BRIDGE

REQUEST DETAILED TRAFFIC FROM PLANNING SURVEY

ANALYZE TRAFFIC DATA FOR SIGNALS AND LIGHTING

SELECT TYPE OF EQUIPMENT TO MEET TRAFFIC CONDITIONS

MAKE FINAL CHANGES AS REQUIRED BY COMMITTEE

DEVELOP PRELIMINARY SUMMARIES FOR E.P.L.H.

TRANSMIT PRINTS TO DESIGNER

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FROM PAGE 10 (17)

UPDATE THE TITLE SHEET

DEVELOP THE TENTATIVE TABLE OF CONTENTS

DEVELOP THE GENERAL NOTES SHEET

UPDATE THE TYPICAL SECTION SHEETS

PREPARE THE SUMMARY FRAMES

OBTAIN THE DETAIL SHEETS INCLUDING STANDARD DRAWINGS

ESTABLISH DATE OF FPI H WITH DISTRICT AND FHW A

WRITE COVER LETTER FOR F.P.I.H. TO INDICATE TIME AND PLACE

REQUEST AND RECEIVE PRINTS OF ALL FPI H PLANS

DISTRIBUTE PRINTS FOR FPI.H. TO ALL INTERESTED PARTIES

TRANSMIT IRRIGATION ESTIMATE TO THE BUREAU OF RIGHT OF WAY

CONDUCT OFFICE REVIEW OF FPI.H PLANS IN FIELD

CONDUCT FIELD REVIEW OF FPI.H PLANS IN FIELD

DEVELOP NATURAL RESOURCES REPORT

TRANSMIT NATURAL RESOURCES REPORT TO THE PRECONSTRUCTION ENGINEER

TO PAGE 13 (18)

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WAS A MINORITY REPORT FILED ?

NO

TO PAGE 13 (20)

YES

OBTAIN DECISION ON POINT OF MINOR CONFLICT

TO PAGE 13 (21)

DET MINE THE NEED FOR SPECIAL STUDY FOR MAJOR PROBLEM

NOTIFY CONSULTANT TO ACCOMPLISH SPECIFIC STUDY

RECEIVE DATA AND PERTINENT INFORMATION

STUDY DATA AND DETERMINE POTENTIAL SOLUTION TO PROBLEM

REQUEST APPROVAL OF SOLUTION TO PROBLEM

OBTAIN DEPARTMENT DECISION ON SOLUTION TO MAJOR PROBLEM

TO PAGE 13 (22)

REQUEST BUREAU OF RIGHT OF WAY TO ACCOMPLISH SPECIFIC STUDY

REQUEST BUREAU OF MATERIALS TO ACCOMPLISH SPECIFIC STUDY

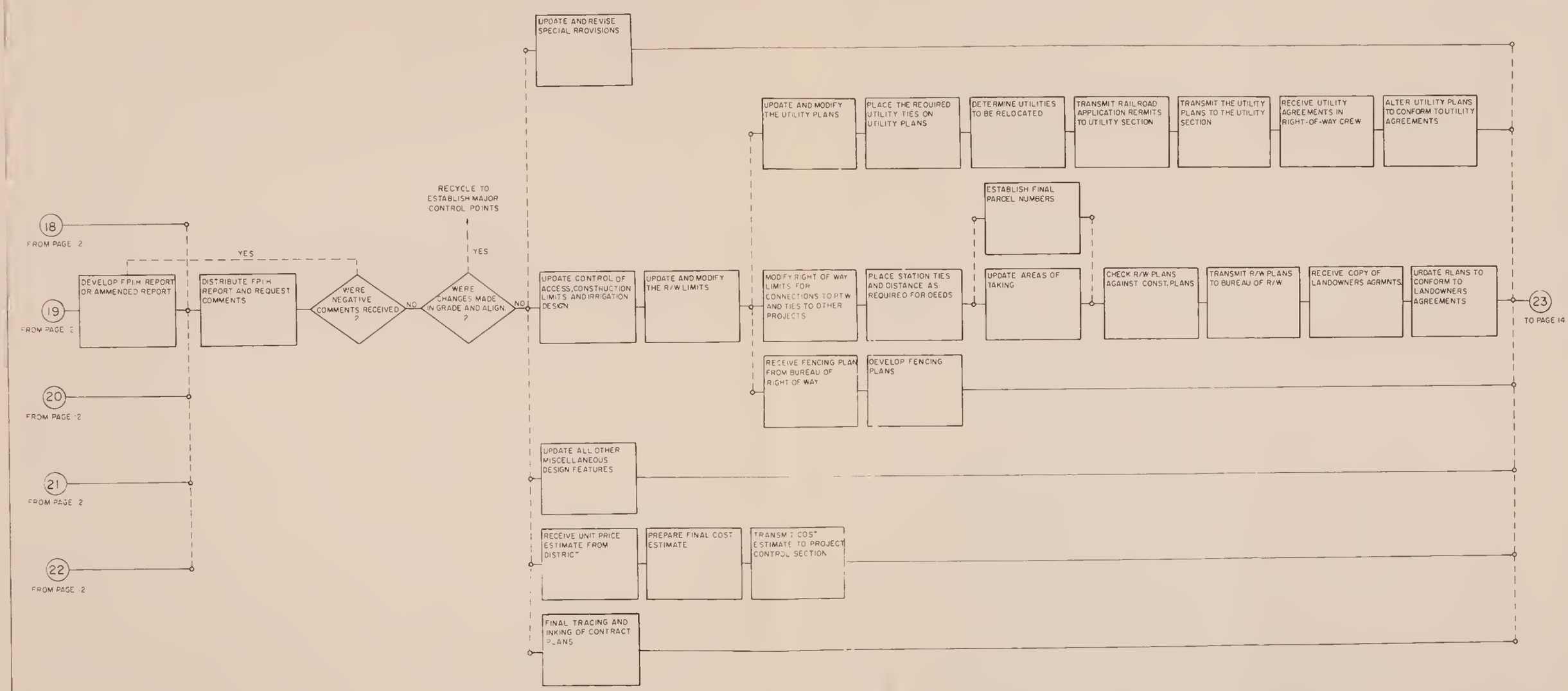
REQUEST BUREAU OF BRIDGE TO ACCOMPLISH SPECIFIC STUDY

REQUEST THE TRAFFIC UNIT TO ACCOMPLISH SPECIFIC STUDY

REQUEST DISTRICT TO ACCOMPLISH SPECIFIC STUDY

REQUEST HYDRAULICS UNIT TO ACCOMPLISH SPECIFIC STUDY

REQUEST PUBLIC AGENCIES TO ACCOMPLISH SPECIFIC STUDY


UPDATE AND REVISE SPECIAL PROVISIONS
UPDATE AND MODIFY THE UTILITY PLANS
PLACE THE REQUIRED UTILITY TIES ON UTILITY PLANS
DETERMINE UTILITIES TO BE RELOCATED
TRANSMIT RAILROAD APPLICATION PERMITS TO UTILITY SECTION
TRANSMIT THE UTILITY PLANS TO THE UTILITY SECTION
RECEIVE UTILITY AGREEMENTS IN RIGHT-OF-WAY CREW
ALTER UTILITY PLANS TO CONFORM TO UTILITY AGREEMENTS
ESTABLISH FINAL PARCEL NUMBERS
RECYCLE TO ESTABLISH MAJOR CONTROL POINTS
18
FROM PAGE 2
YES
YES
DEVELOP FPIM REPORT OR AMMENDED REPORT
DISTRIBUTE FPIM REPORT AND REQUEST COMMENTS
WERE NEGATIVE COMMENTS RECEIVED ?
NO
WERE CHANGES MADE IN GRADE AND ALIGN. ?
NO
UPDATE CONTROL OF ACCESS, CONSTRUCTION LIMITS AND IRRIGATION DESIGN
UPDATE AND MODIFY THE R/W LIMITS
MODIFY RIGHT OF WAY LIMITS FOR CONNECTIONS TO PTW AND TIES TO OTHER PROJECTS
PLACE STATION TIES AND DISTANCE AS REQUIRED FOR DEEDS
UPDATE AREAS OF TAKING
CHECK R/W PLANS AGAINST CONST. PLANS
TRANSMIT R/W PLANS TO BUREAU OF R/W
RECEIVE COPY OF LANDOWNERS AGRMNTS.
URDATE PLANS TO CONFORM TO LANDOWNERS AGREEMENTS
23
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RECEIVE FENCING PLAN FROM BUREAU OF RIGHT OF WAY
DEVELOP FENCING PLANS
20
FROM PAGE 2
UPDATE ALL OTHER MISCELLANEOUS DESIGN FEATURES
21
FROM PAGE 2
RECEIVE UNIT PRICE ESTIMATE FROM DISTRICT
PREPARE FINAL COST ESTIMATE
TRANSMIT COST ESTIMATE TO PROJECT CONTROL SECTION
22
FROM PAGE 2
FINAL TRACING AND INKING OF CONTRACT PLANS

FROM PAGE 13
23
TRANSMIT PLANS, CROSS SECTION, SPEC. PROVISIONS AND FILE TO CHECKER
REVIEW AND CHECK CONTRACT PLANS
TRANSMIT CONTRACT PLANS AND DATA TO CONTRACT PLANS UNIT
24
TO CONTRACT PLANS WORKFLOW

CHECK SHEET

ITEM AND DESCRIPTION	RESPONSIBILITY — DESIGNER: P.P.I.H. PLANS	DESIGNER: F.P.I.H. PLANS	DESIGNER: FINAL PLANS	CHECKER: FINAL PLANS
Title Sheet				
1. Project number, name and agreement number				X
2. Beginning and ending stations	X	X	X	
3. Major feature station locations		X	X	
4. Project splits		X		X
5. Layout map				
+ Alignment	X		X	
+ Township, range and ties	X		X	
+ North arrow orientation	X		X	
6. Signature block	X		X	
7. Design data	X		X	
8. Plan scales	X		X	
9. Optioned surfacing and borrow source		X		X
Symbols and Abbreviations				
1. Consistent usage	X	X	X	
Table of Contents				
1. Verify sheet numbers and prefix		X	X	
2. Proper project number on pages				X
3. Correct title headings and sub-headings		X	X	

ITEM AND DESCRIPTION	RESPONSIBILITY			
	DESIGNER			CHECKER
	P.P.I.H. PLANS	F.P.I.H. PLANS	FINAL PLANS	FINAL PLANS
Notes				
1. Standard Notes				
+ Skew diagram	X	X	X	
+ Bases for plan quantities for surfacing	X	X		X
+ Slope notes	X		X	
+ Control of access note		X	X	
+ Project staking note		X	X	
2. Non-Standard Notes				
+ Misc. to be removed or moved by others		X		X
+ Misc. to be removed by contractor note (Absorbed items)		X	X	
+ Do not disturb note		X	X	
+ Clearing and grubbing note		X	X	
+ Dump area note		X	X	
+ Furrow ditches		X	X	
+ Approaches note		X	X	
+ Seeding note		X		X
+ Detour note		X	X	
Linear and Level Data				
1. Linear Data				
+ Total length of project		X		X
+ Length of structures		X		X
+ Equation adjustments		X		X
+ Project splits		X		X

ITEM AND DESCRIPTION	RESPONSIBILITY: DESIGNER P.P.I.H. PLANS	DESIGNER F.P.I.H. PLANS	DESIGNER FINAL PLANS	CHECKER FINAL PLANS
2. Bearings Note		X		X
3. Bench Mark				
+ Location and Description		X	X	
+ Elevation		X	X	
+ Level Datum Source and Description		X	X	
Typical Section				
1. Dimensions				
+ Vertical	X	X		X
+ Horizontal	X	X		X
2. End areas and volumes	X	X		X
3. Applicable stationing for typical section	X	X	X	
4. Typical numbers	X	X	X	
5. Typical titles	X	X	X	
6. Surfacing lift descriptions and types	X	X		X
7. Profile elevation note	X	X	X	
Summaries				
1. Grading frame	X	X		X
2. Additional excavation frame		X		X
3. Topsoil frame		X		X
4. Culvert frame		X		X
5. Culvert-alternate frame		X		X
6. Irrigation frame		X		X
7. Embankment protector frame		X		X

ITEM AND DESCRIPTION	RESPONSIBILITY: DESIGNER P.P.I.H. PLANS	DESIGNER F.P.I.H. PLANS	DESIGNER FINAL PLANS	CHECKER FINAL PLANS
8. Drainage frame		X		X
9. Slope protector frame		X		X
10. Surfacing frame		X		X
11. Additional surfacing frame		X		X
12. Seeding frame		X		X
13. Guard rail and median rail frame		X		X
14. Curb and gutter frame		X		X
15. Sidewalk frame		X		X
16. Cattle guard frame		X		X
17. Monuments and markers frame		X		X
18. Miscellaneous to be removed by contractor frame (bid items)		X		X
19. Reset and adjustment frame		X		X
Detail				
1. Required detail drawings				
+ Quantities		X	X	
+ Dimensions		X	X	
+ Notes		X		X
2. Required standard drawings		X		X
3. Mass diagram (single page)		X		X
Plan and Profile				
1. Alignment				
+ Staked	X	X		X
+ Projected	X	X		X

ITEM AND DESCRIPTION	RESPONSIBILITY			
	DESIGNER			CHECKER
	P.P.I.H. PLANS	F.P.I.H. PLANS	FINAL PLANS	FINAL PLANS
2. Topography				
+ Utility				X
+ Irrigation and drainage			X	
+ Buildings			X	
+ Other miscellaneous topography			X	
3. Grade				
+ I.B.M. runs	X	X		X
+ Profile	X	X		X
+ Vertical curve data	X	X		X
4. Mass diagram (large scale)		X	X	
5. Station call outs and notes		X	X	
6. North arrow orientation		X	X	
7. Township, range and ties		X	X	
8. Section lines		X	X	
9. Right-of-way limits		X		X
10. Control of access		X		X
11. Connection to P.T.W.		X		X
Cross Sections				
1. Notes		X	X	
2. Typical Template		X	X	
3. Topography		X	X	
4. Areas and volumes		X	X	

ORGANIZATION

CONTENTS

EXISTING ORGANIZATION

+ Existing organization chart

REVISED ORGANIZATION

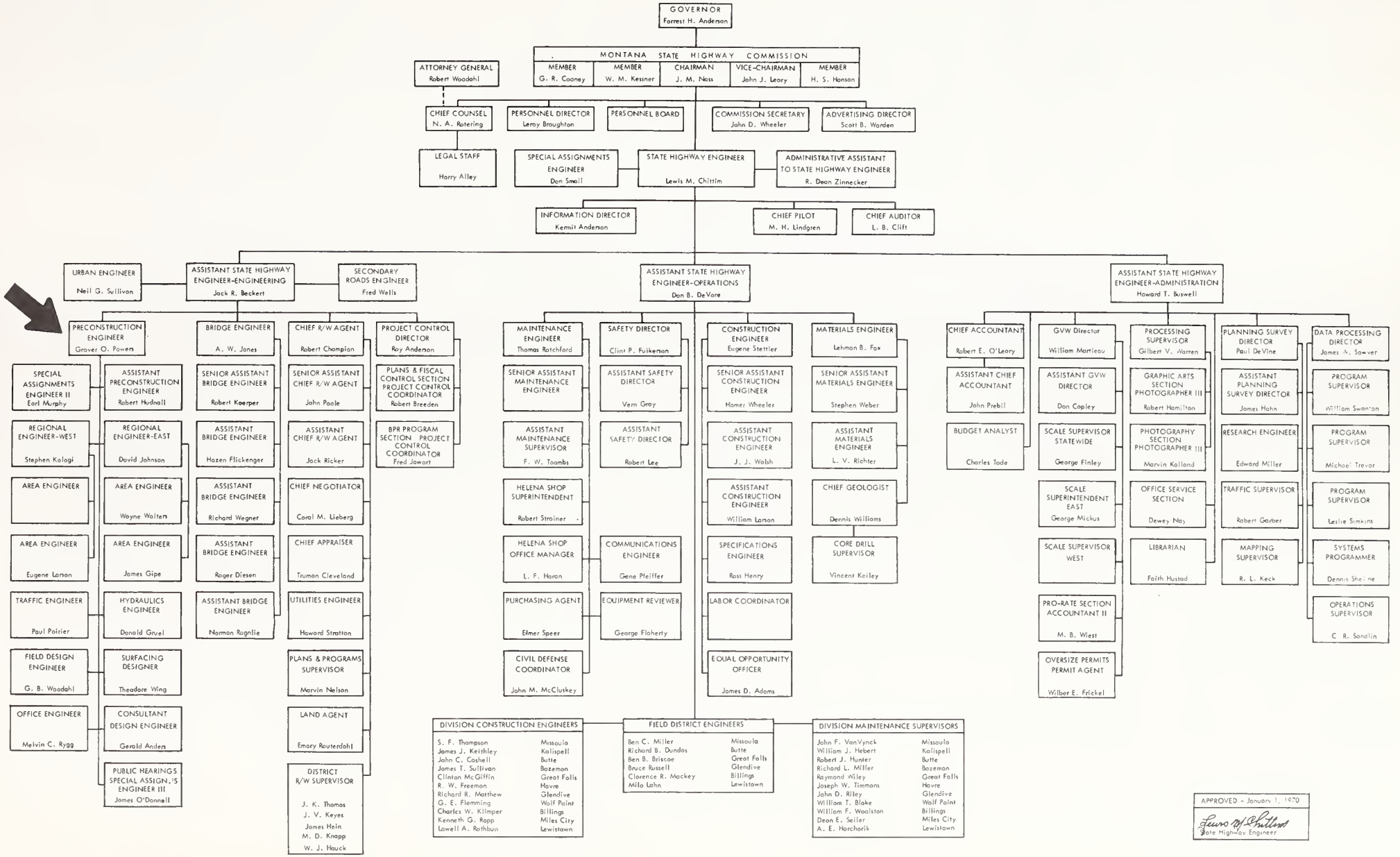
+ Revised organization charts

+ Position guides

EXISTING ORGANIZATION

The organization of the Preconstruction function existing at the time the project was initiated is shown on the following page. Further definitions of authority and responsibility were nonexistent, included in memoranda or concluded from the relationships shown on the chart.

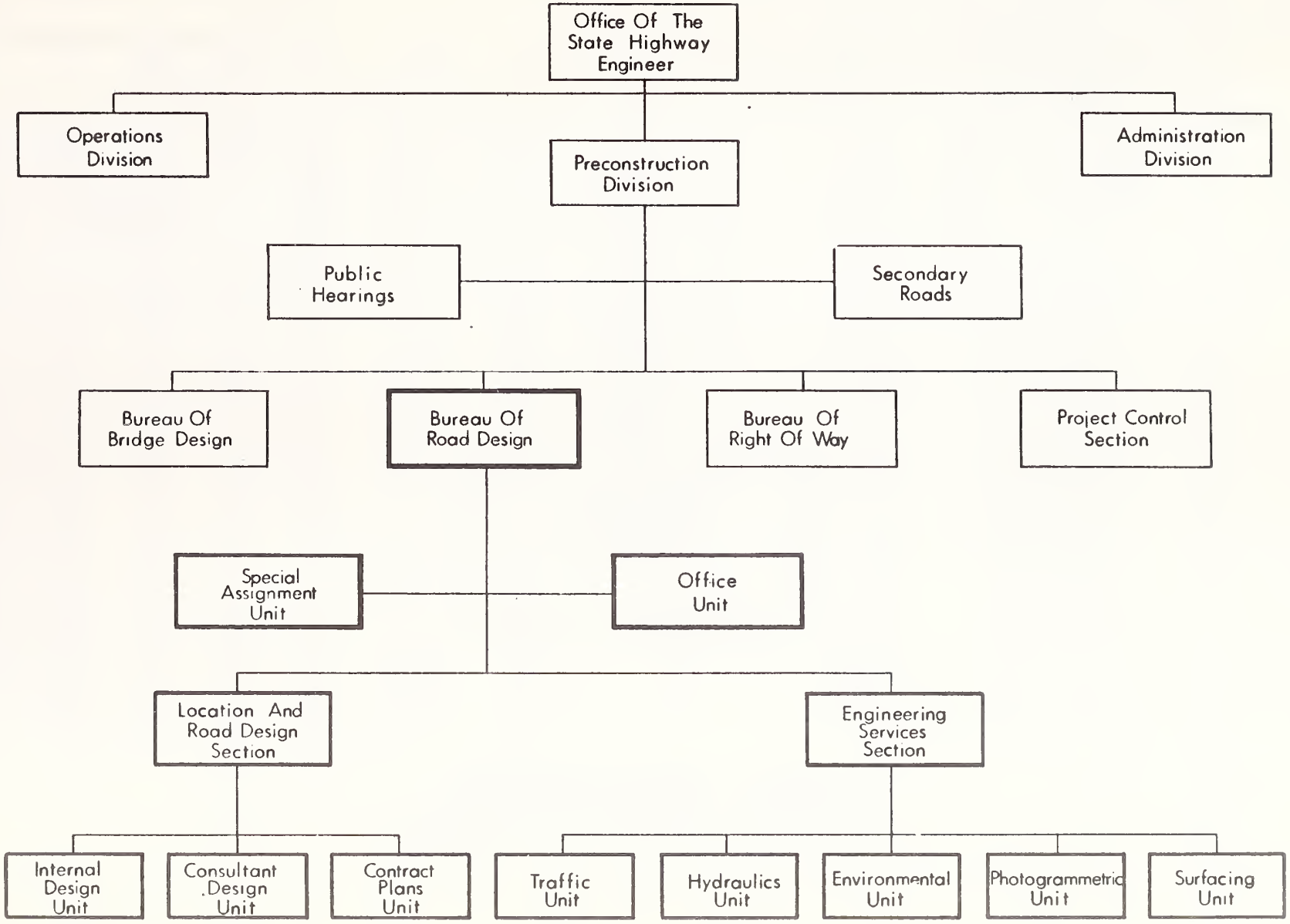
MONTANA STATE HIGHWAY COMMISSION
ORGANIZATION STRUCTURE


GOVERNOR
Forrest H. Anderson
MONTANA STATE HIGHWAY COMMISSION
MEMBER G. R. Cooney
MEMBER W. M. Kessner
CHAIRMAN J. M. Nass
VICE-CHAIRMAN John J. Leary
MEMBER H. S. Hanson
ATTORNEY GENERAL Robert Woodahl
CHIEF COUNSEL N. A. Rotering
PERSONNEL DIRECTOR Leroy Broughton
PERSONNEL BOARD
COMMISSION SECRETARY John D. Wheeler
ADVERTISING DIRECTOR Scott B. Worden
LEGAL STAFF Harry Alley
SPECIAL ASSIGNMENTS ENGINEER Don Small
STATE HIGHWAY ENGINEER Lewis M. Chittim
ADMINISTRATIVE ASSISTANT TO STATE HIGHWAY ENGINEER R. Dean Zinnecker
INFORMATION DIRECTOR Kermit Anderson
CHIEF PILOT M. H. Lindgren
CHIEF AUDITOR L. B. Clift
URBAN ENGINEER Neil G. Sullivan
ASSISTANT STATE HIGHWAY ENGINEER-ENGINEERING Jack R. Beckert
SECONDARY ROADS ENGINEER Fred Wells
ASSISTANT STATE HIGHWAY ENGINEER-OPERATIONS Don B. DeVore
ASSISTANT STATE HIGHWAY ENGINEER-ADMINISTRATION Howard T. Buswell
PRECONSTRUCTION ENGINEER Grover O. Powers
SPECIAL ASSIGNMENTS ENGINEER II Earl Murphy
REGIONAL ENGINEER-WEST Stephen Kologi
AREA ENGINEER
AREA ENGINEER Eugene Larson
TRAFFIC ENGINEER Paul Poirier
FIELD DESIGN ENGINEER G. B. Woodahl
OFFICE ENGINEER Melvin C. Rygg
ASSISTANT PRECONSTRUCTION ENGINEER Robert Hudnall
REGIONAL ENGINEER-EAST David Johnson
AREA ENGINEER Wayne Walters
AREA ENGINEER James Gipe
HYDRAULICS ENGINEER Donald Gruel
SURFACING DESIGNER Theadore Wing
CONSULTANT DESIGN ENGINEER Gerald Anders
PUBLIC HEARINGS SPECIAL ASSIGN.'S ENGINEER III James O'Donnell
BRIDGE ENGINEER A. W. Jones
SENIOR ASSISTANT BRIDGE ENGINEER Robert Koerper
ASSISTANT BRIDGE ENGINEER Hazen Flickenger
ASSISTANT BRIDGE ENGINEER Richard Wegner
ASSISTANT BRIDGE ENGINEER Roger Diesen
ASSISTANT BRIDGE ENGINEER Norman Ragnlie
CHIEF R/W AGENT Robert Champion
SENIOR ASSISTANT CHIEF R/W AGENT John Poole
ASSISTANT CHIEF R/W AGENT Jack Ricker
CHIEF NEGOTIATOR Carol M. Lieberg
CHIEF APPRAISER Truman Cleveland
UTILITIES ENGINEER Haword Stratton
PLANS & PROGRAMS SUPERVISOR Marvin Nelson
LAND AGENT Emory Routerdahl
DISTRICT R/W SUPERVISOR
J. K. Thomas
J. V. Keyes
James Hein
M. D. Knapp
W. J. Hauck
PROJECT CONTROL DIRECTOR Roy Anderson
PLANS & FISCAL CONTROL SECTION PROJECT CONTROL COORDINATOR Robert Breeden
BPR PROGRAM SECTION PROJECT CONTROL COORDINATOR Fred Jawort
MAINTENANCE ENGINEER Thomas Ratchford
SENIOR ASSISTANT MAINTENANCE ENGINEER
ASSISTANT MAINTENANCE SUPERVISOR F. W. Toombs
HELENA SHOP SUPERINTENDENT Robert Strainer
HELENA SHOP OFFICE MANAGER L. F. Haran
PURCHASING AGENT Elmer Speer
CIVIL DEFENSE COORDINATOR John M. McCluskey
SAFETY DIRECTOR Clint P. Fulkerson
ASSISTANT SAFETY DIRECTOR Vern Gray
ASSISTANT SAFETY DIRECTOR Robert Lee
COMMUNICATIONS ENGINEER Gene Pfeiffer
EQUIPMENT REVIEWER George Flaherty
CONSTRUCTION ENGINEER Eugene Stettler
SENIOR ASSISTANT CONSTRUCTION ENGINEER Homer Wheeler
ASSISTANT CONSTRUCTION ENGINEER J. J. Walsh
ASSISTANT CONSTRUCTION ENGINEER William Larson
SPECIFICATIONS ENGINEER Ross Henry
LABOR COORDINATOR
EQUAL OPPORTUNITY OFFICER James D. Adams
MATERIALS ENGINEER Lehman B. Fox
SENIOR ASSISTANT MATERIALS ENGINEER Stephen Weber
ASSISTANT MATERIALS ENGINEER L. V. Richter
CHIEF GEOLOGIST Dennis Williams
CORE DRILL SUPERVISOR Vincent Keiley
CHIEF ACCOUNTANT Robert E. O'Leary
ASSISTANT CHIEF ACCOUNTANT John Prebil
BUDGET ANALYST Charles Tode
GVW Director William Marticau
ASSISTANT GVW DIRECTOR Don Copley
SCALE SUPERVISOR STATEWIDE George Finley
SCALE SUPERINTENDENT EAST George Mickus
SCALE SUPERVISOR WEST
PRO-RATE SECTION ACCOUNTANT II M. B. Wiest
OVERSIZE PERMITS PERMIT AGENT Wilber E. Frickel
PROCESSING SUPERVISOR Gilbert V. Warren
GRAPHIC ARTS SECTION PHOTOGRAPHER III Robert Hamilton
PHOTOGRAPHY SECTION PHOTOGRAPHER III Marvin Kalland
OFFICE SERVICE SECTION Dewey Nay
LIBRARIAN Faith Hustad
PLANNING SURVEY DIRECTOR Paul DeVine
ASSISTANT PLANNING SURVEY DIRECTOR James Hahn
RESEARCH ENGINEER Edward Miller
TRAFFIC SUPERVISOR Robert Garber
MAPPING SUPERVISOR R. L. Keck
DATA PROCESSING DIRECTOR James N. Sawyer
PROGRAM SUPERVISOR William Swanton
PROGRAM SUPERVISOR Michael Trevor
PROGRAM SUPERVISOR Leslie Simkins
SYSTEMS PROGRAMMER Dennis Sheline
OPERATIONS SUPERVISOR C. R. Sandlin
DIVISION CONSTRUCTION ENGINEERS
S. F. Thompson Missoula
James J. Keithley Kalispell
John C. Cashell Butte
James T. Sullivan Bozeman
Clinton McGiffin Great Falls
R. W. Freeman Havre
Richard R. Matthew Glendive
G. E. Flemming Wolf Point
Charles W. Klimper Billings
Kenneth G. Rapp Miles City
Lowell A. Rothbun Lewistown
FIELD DISTRICT ENGINEERS
Ben C. Miller Missoula
Richard B. Dundas Butte
Ben B. Briscoe Great Falls
Bruce Russell Glendive
Clarence R. Mackey Billings
Milo Lahn Lewistown
DIVISION MAINTENANCE SUPERVISORS
John F. VanVynck Missoula
William J. Hebert Kalispell
Robert J. Hunter Butte
Richard L. Miller Bozeman
Raymond Wiley Great Falls
Joseph W. Timmons Havre
John D. Riley Glendive
William T. Blake Wolf Point
William F. Woolston Billings
Dean E. Seiler Miles City
A. E. Harchorik Lewistown
APPROVED - January 1, 1970
State Highway Engineer

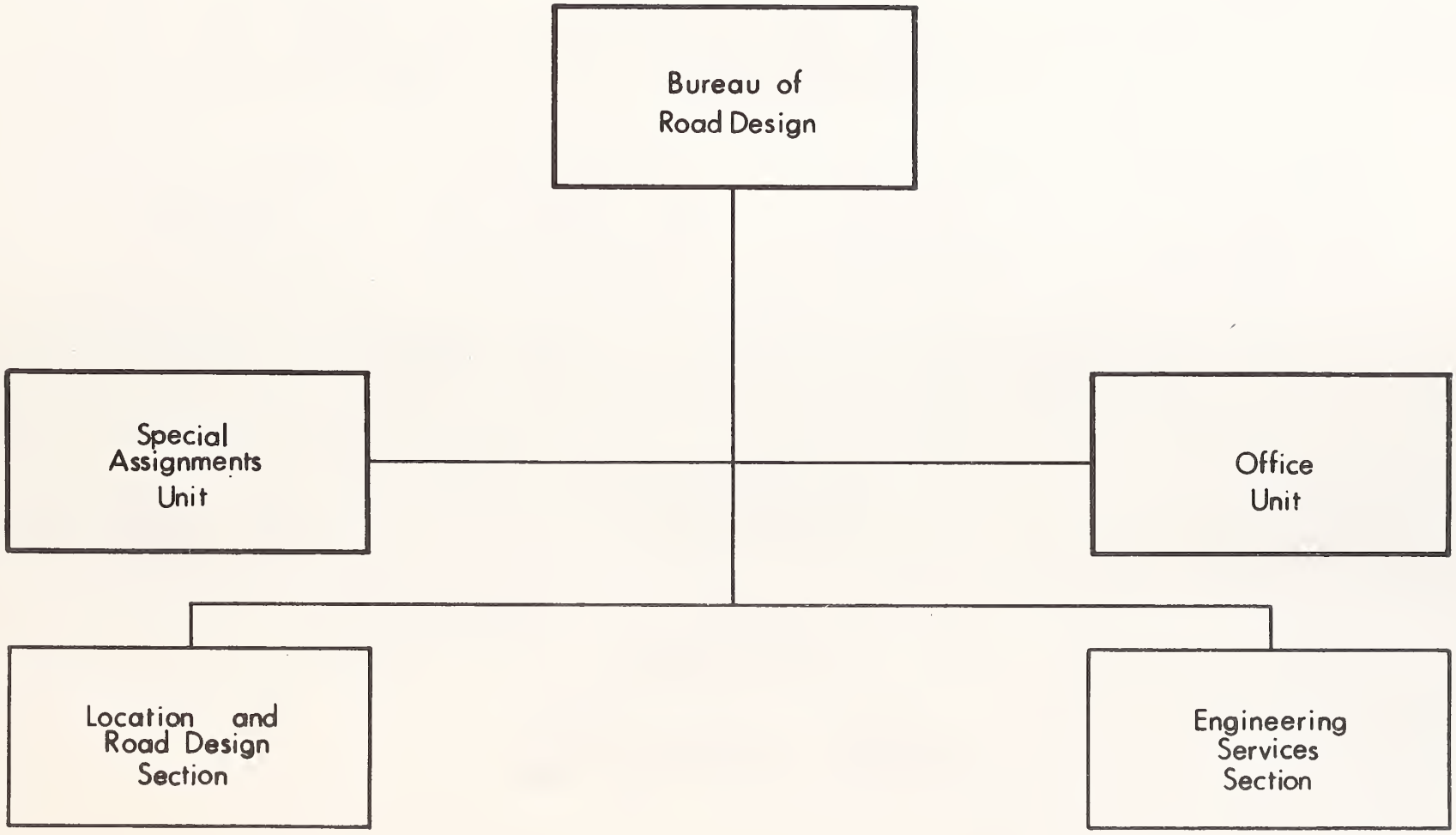
REVISED ORGANIZATION

The recommended organization was based on the work system requirements. The function, responsibility and authority statements shown on the position guides were developed from the work analysis and procedures presented in the preceeding section.

PRECONSTRUCTION DIVISION ORGANIZATION CHART



BUREAU OF ROAD DESIGN
ORGANIZATION CHART



POSITION GUIDE

CHIEF, BUREAU OF ROAD DESIGN

Date Issued

I. FUNCTION

The Chief, Bureau of Road Design accomplishes the location and design of all highway projects required in the construction program and administers all design service unit activities including those of Hydraulics, Traffic, Environmental, Photogrammetrics and Contract Plans in accordance with Department and Statutory requirements.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Chief, Bureau of Road Design is responsible for and has the authority to perform or cause to be performed the following:

A. Activities

1. Supervises the following subordinate personnel:

   a) Supervisor of Location and Road Design Section
   b) Supervisor of Engineering Service Section
   c) Manager of Special Assignments Unit
   d) Manager of Office Unit

2. Implements Department policy and develops recommendations for needed changes in policy that affect the road design function.

3. Approves procedures in accordance with Department policy for use in the performance of design or design service functions.

4. Participates in the long-range highway planning function, including programming of projects.

5. Approves project schedules and ensures accomplishment of scheduled objectives.

6. Develops budgets for the Bureau of Road Design and approves expenditures of funds.

7. Approves and implements the planning guidelines for use in planning, programming and scheduling work. Periodically reviews the validity of the values and recommends revisions based on legislative action, Federal Highway Administration requirements, Bureau experience or other appropriate criteria.

II. RESPONSIBILITY AND AUTHORITY (continued)

8. Implements the training program.

9. Approves standard drawings and standard sheets.

10. Provides for the location, design authorization to receive bids, and contract negotiations in accordance with statutory requirements.

11. Provides for contracts with consulting firms for the preliminary engineering and design of highways.

12. Provides for the documentation of projects in accordance with statutory regulations, Department policy and Federal Highway Administration requirements.

13. Approves plans, specifications and estimates for final advertising.

B. Organization

1. Develops and maintains an effective and efficient organization in the Bureau of Road Design.

2. Ensures that all employees in the Bureau of Road Design understand the responsibilities of their positions and that position guides, policies and procedures for the Bureau of Road Design are current and adequate.

3. Delegates authority to subordinates consistent with their duties and abilities.

C. Personnel

1. Provides for the training and development of employees within the Bureau of Road Design.

2. Approves personnel actions affecting subordinates.

3. Approves staffing requirements of the Bureau of Road Design based on workload and optimum manpower utilization.

4. Provides for performance review and appraisal of subordinates.

POSITION GUIDE

CHIEF, BUREAU OF ROAD DESIGN

Date Issued

III. RELATIONSHIPS

A. With the Administrator, Preconstruction Division --

1. Accounts to him for the direction and execution of responsibilities in the Bureau of Road Design.

2. Advises of significant developments and reviews major programs and plans for the Bureau of Road Design.

B. With the Chief, Bureau of Bridge Design --

1. Coordinates with him to ensure that road and structure plans are compatible.

C. With the Supervisor of the Project Control Section --

1. Coordinates with him to ensure attainment of Department objective and maintenance of proper priorities.

D. With other Divisions, Sections and Districts --

1. Develops and maintains close relationships to ensure that Bureau of Road Design is represented in decisions related to this function.

E. With the Federal Highway Administration, other Agencies, Contractors and Suppliers --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

F. With the General Public --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

2. Acts as a representative of the State Highway Engineer.

POSITION GUIDE

MANAGER, SPECIAL ASSIGNMENTS UNIT

Date Issued

I. FUNCTION

The Manager, Special Assignments Unit, directs or controls all non-routine projects analysis, and provides guidance to all units on special studies in the Bureau of Road Design.

II. RESPONSIBILITIY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Manager, Special Assignments Unit is responsible for and has the authority to perform or cause to be performed the following:

A. Provides assistance in developing and maintaining information in the Bureau of Road Design which is required in non-routine problem solving.

B. Assists units in the Bureau of Road Design in the development of procedure change recommendations.

C. Coordinates the effective implementation of training material with the Bureau of Personnel.

D. Develops and recommends courses of action designed to establish and maintain training in the Bureau of Road Design.

E. Analyzes the Annual Standards Adjustment Report of all Bureau of Road Design organizational units to determine the appropriateness of planning values and make recommendations for changes.

F. Maintains the Design Management Manual and Design Manual.

G. Prepares special reports and correspondence, coordinates the release of special information and evaluates the need for additional reporting.

H. Receives and distributes mail.

III. RELATIONSHIPS

A. With the Chief, Bureau of Road Design --

1. Reports to and is accountable to the Chief, Bureau of Road Design for the proper interpretation and effective performance of his duties and responsibilities.

POSITION GUIDE

MANAGER, SPECIAL ASSIGNMENTS UNIT

Date Issued

III. RELATIONSHIPS (continued)

B. With the Administration, Preconstruction Division --

1. Gathers and develops special road design data as requested.

C. With all Bureau of Road Design Organization Units --

1. Maintains effective relationships to ensure full consideration of all applicable data and conditions on which the procedures are based.

POSITION GUIDE

MANAGER, OFFICE UNIT

Date Issued

I. FUNCTION

The Manager, Office Unit directs and controls for the Bureau of Road Design, the collection and reporting of all financial and statistical data, and supervises the accounting, payroll and purchasing function.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Manager, Office Unit is responsible for and has the aurhority to perform or cause to be performed the following:

A. Directs or supervises the work activities of personnel assigned to the Office Unit.

B. Provides systems for complying with all Department and Federal Highway Administration requirements for financial, statistical and management reporting.

C. Provides financial, fiscal accounting, payroll, and purchasing services for the Bureau of Road Design.

III. RELATIONSHIPS

A. With the Chief, Bureau of Road Design --

1. Reports to and is accountable to the Chief, Bureau of Road Design for the proper interpretation and effective performance of his duties and responsibilities.

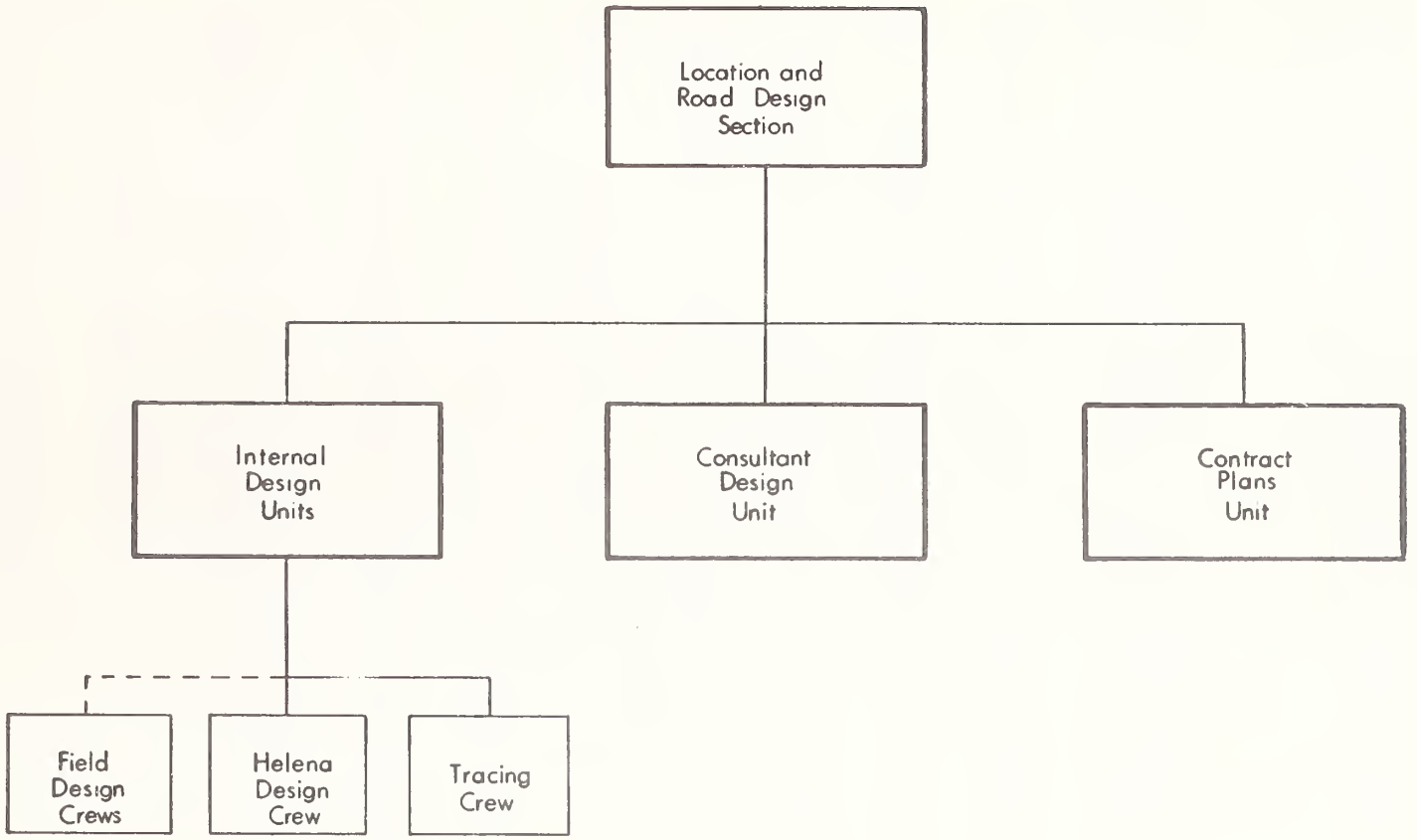
B. With the Department Accounting Personnel --

1. Maintains effective relationships to ensure necessary results in all matters dealing with the Bureau of Road Design.

C. With Federal Highway Administration Personnel --

1. Maintains relationships with the Federal Highway Administration personnel that will facilitate the free flow of information and ensure necessary understanding and implementation of Bureau policies, procedures and problems as they pertain to functions of the office unit.

LOCATION AND ROAD DESIGN SECTION
ORGANIZATION CHART



POSITION GUIDE

LOCATION AND ROAD DESIGN SUPERVISOR

Date Issued

I. FUNCTION

The Supervisor, Location and Road Design Section directs and controls all internal and external road design and location activities required in the construction program.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Supervisor, Location and Road Design Section is responsibile for and has the authority to perform or cause to be performed the following:

A. Directs or supervises the following subordinate positions:

1. Senior Supervisors, Internal Design Unit
2. Manager, Consultant Design Unit
3. Manager, Contract Plans Unit

B. Develops detailed road design schedules and recommends their adoption.

C. Approves short-range design project schedules, analyzes the schedules to determine the staffing requirements and initiates
p r personnel changes to effect maximum manpower utilization.

D. Develops and recommends changes in procedure designed to improve the effectiveness of the design operations.

E. Provides for the development of standard drawings and standard sheets.

F. Coordinates the road design of field design crews, reviews their work for adequacy and accuracy, provides them with technical guidance and recommends ways they may improve.

G. Provides guidance and assistance to outside governmental agencies in carrying out the provisions of federal and state highway programs which relate to road design.

H. Recommends final project design.

III. RELATIONSHIPS

A. With the Chief, Bureau of Road Design --

1. Reports to and is accountable to the Chief, Bureau of Road Design for the proper interpretation and effective performance of his duties and responsibilities.

POSITION GUIDE

LOCATION AND ROAD DESIGN SUPERVISOR

Date Issued

III. RELATIONSHIPS (continued)

B. With the Supervisor, Engineering Services Section --

1. Reviews design matters with him to ensure a coordinated effort toward meeting project objectives.

2. Advises of significant project developments which will affect their activities and schedules.

C. With the Chief, Bureau of Right-of-Way --

1. Coordinates road design and right-of-way plan preparation to ensure coordinated efforts toward Department objectives.

D. With the Chief, Bureau of Bridge Design --

1. Coordinates with him to ensure that road design is consistent with structure design.

E. With other Divisions, Sections and Districts --

1. Develops and maintains close relationships to ensure that all factors are considered, in decisions relative to location and road design.

F. With the Federal Highway Administration, other Agencies, Contractors and Suppliers --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

G. With the General Public --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

POSITION GUIDE

SENIOR SUPERVISOR

Date Issued

I. FUNCTION

The Senior Supervisor administers the location and project design accomplished by the Department.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Senior Supervisor is responsible for and has the authority to perform or cause to be performed the following:

A. Supervises the project level personnel assigned to specific projects.

B. Recommends adjustments in manpower and/or project schedules as necessary to ensure balance between work loads and manpower availability.

C. Recommends short-range design project schedules.

D. Recommends changes in procedure designed to improve the effectiveness of the design operations.

E. Coordinates the field design crews in the accomplishment of road design according to adopted Department policies and procedures as well as Federal Highway Administration requirements.

F. Ensures the assembly of pertinent data and appropriate studies to determine highway routings and locations.

G. Develops or directs the development of project reports including planning report, plan-in-hand reports, and public hearing reports.

H. Directs and controls final project design.

III. RELATIONSHIPS

A. With the Supervisor, Location and Road Design Section --

1. Reports to and is accountable to the Supervisor, Location and Road Design Section for the proper interpretation and effective performance of his duties and responsiblities.

POSITION GUIDE

SENIOR SUPERVISOR

Date Issued

III. RELATIONSHIPS (continued)

B. With other Divisions, Sections and Districts --

1. Develops and maintains relationships to ensure that all factors are considered in decisions relative to location and road design accomplished by the Department.

C. With the Federal Highway Administration, other Agencies, Contractors and Suppliers --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

POSITION GUIDE

MANAGER, CONSULTANT DESIGN UNIT

Date Issued

I. FUNCTION

The Manager, Consultant Design Unit administers and directs the activities of consultants engaged by the Department in highway location and design.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved Procedures, the Manager, Consultant Design Unit is responsible for and has the authority to perform or cause to be performed the following:

A. Supervises the work activities of personnel assigned to the Consultant Design Unit.

B. Coordinates department services with the development of location recommendations and/or the preparation of plans and other engineering services provided by consultants.

C. Administers policies and procedures governing preliminary engineering work by consultant firms.

D. Reviews and recommends any changes in alignment or plans recommended by a consultant firm.

E. Arranges for and coordinates field reviews and public hearings on projects being designed by consultant firms.

F. Determines that project design is complete and recommends final approval.

G. Reviews and recommends approval on claims for payments submitted by consultant firms.

H. Negotiates extra work extensions or changes in the consultant agreements.

I. Develops project assignments for specific projects.

III. RELATIONSHIPS

A. With the Supervisor, Location and Road Design Section --

1. Reports to and is accountable to the Supervisor, Location and Road Design Section for the proper interpretation and effective performance of his duties and responsibilities.

POSITION GUIDE

MANAGER, CONSULTANT DESIGN UNIT

Date Issued

III. RELATIONSHIPS (continued)

B. With other Divisions, Sections and Districts --

1. Develops and maintains close relationships to ensure all factors are considered in decisions relative to road design accomplished by consultant forces.

C. With the Federal Highway Administration, other Agencies, Contractors and Suppliers --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

D. With the General Public --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

POSITION GUIDE

MANAGER, CONTRACT PLANS UNIT

Date Issued

I. FUNCTION

The Manager, Contract Plans Unit administers the compilation and distribution of contract letting documents and related instruments; development of engineers' estimates of project costs conducts contract lettings and documentation of bids and agreements between the Department and contractors, private companies, Federal Highway Administration and other governmental agencies.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Manager, Contract Plans Unit is responsible for and has the authority to perform or cause to be performed the following:

A. Supervises the work activities of personnel assigned to the Contract Plans Unit.

B. Coordinates with the various Sections and Divisions to ensure that complete and accurate documents are available at the proper time for preparation of the contract documents.

C. Reviews plans from the various sections to ensure that they are compatible and will result in contract documents which adequately satisfy requirements and regulations and clearly present the project to prospective bidders.

D. Develops contract documents, prepares city and county agreements and performs other related functions necessary to obtain, from the Federal Highway Administration, P S & E approval and secure authority to advertise projects for letting.

E. Arranges for reproducing and assembling plans and proposals; mails contract documents to prospective bidders, suppliers and department personnel, and maintains records and invoices.

F. Performs the various related activities (advertisements, addendum opening and processing of bids) necessary to bring projects to contract letting and to meet post-letting requirements.

POSITION GUIDE

MANAGER, CONTRACT PLANS UNIT

Date Issued

III. RELATIONSHIPS

A. With the Supervisor, Location and Road Design Section --

1. Reports to and is accountable to the Supervisor, Location and Road Design Section for the proper interpretation and effective performance of his duties and responsibilities.

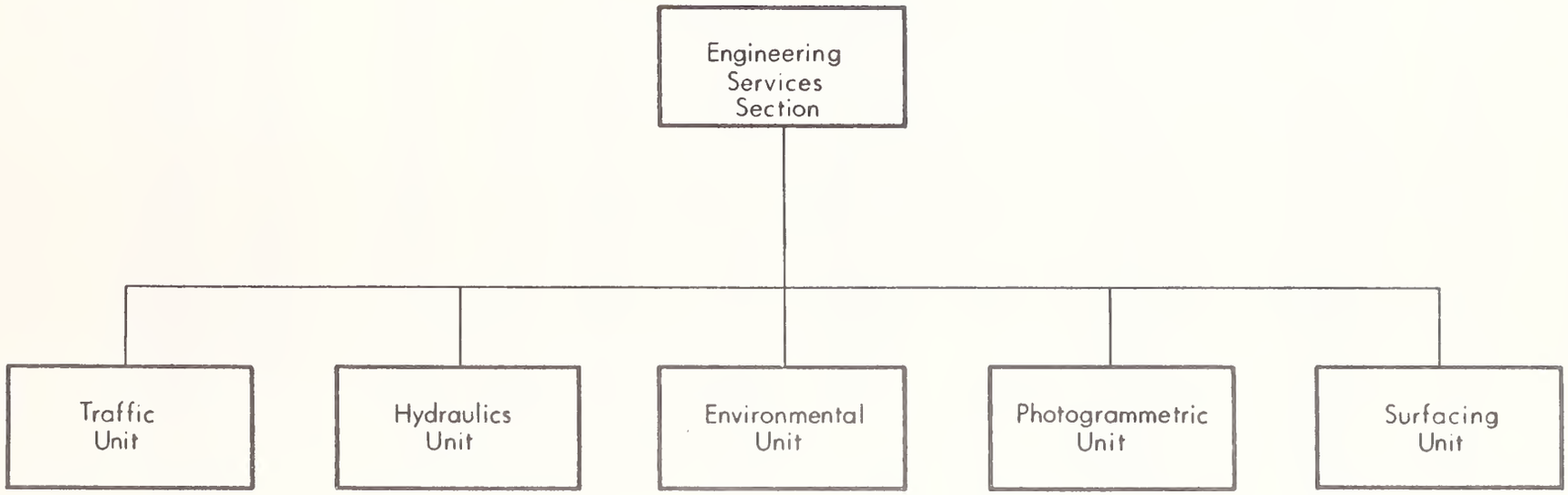
B. With other Divisions, Sections and Districts --

1. Develops and maintains close relationships to ensure that all factors are considered in decisions relative to contract documents and related instruments.

C. With the Federal Highway Administration, other Agencies, Contractors and Suppliers --

1. Establishes and maintains those relationships which are in the best interest of the Department and necessary for the accomplishment of his function.

ENGINEERING SERVICES SECTION
ORGANIZATION CHART



POSITION GUIDE

ENGINEERING SERVICES SUPERVISOR

Date Issued

I. FUNCTION

The Supervisor, Engineering Services Section directs and controls all road design engineering services including Hydraulics, Traffic, Environmental, Photogrammetric and Surfacing Unit.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures the Supervisor, Engineering Service Section is responsible for and has the authority to perform or cause to be performed the following:

A. Directs or supervises the following subordinate positions:

1. Manager, Traffic Unit
2. Manager, Hydraulics Unit
3. Manager, Environmental Unit
4. Manager, Photogrammetric Unit
5. Manager, Surfacing Unit

B. Coordinates engineering services in support of road and bridge design, rights-of-way acquisition and all other Department functions where those services are required.

C. Approves short-range schedules and recommends adoption of schedule objectives for support activities.

D. Develops and recommends changes in procedure designed to improve the effectiveness of the engineering service operations.

E. Provides liaison with political subdivisions which require specialized engineering services.

III. RELATIONSHIPS

A. With the Chief, Bureau of Road Design --

1. Reports to and is accountable to the Chief, Bureau of Road Design for the proper interpretation and effective performance of his duties and responsibilities.

POSITION GUIDE

ENGINEERING SERVICES SUPERVISOR

Date Issued

III. RELATIONSHIPS (continued)

B. With the Supervisor, Location and Road Design Section --

1. Reviews engineering services with him to ensure a coordinated effort toward meeting project objectives.

2. Advises of significant projected developments which will effect road design activities and schedules.

C. With other Divisions, Sections and Districts --

1. Develops and maintains close relationships to ensure that all factors are considered in decisions relative to engineering services.

D. With the Federal Highway Administration, other Agencies, Contractors and Suppliers --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

E. With the General Public --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

POSITION GUIDE

MANAGER, TRAFFIC UNIT

Date Issued

I. FUNCTION

The Manager, Traffic Unit administers the design of traffic control devices; develops proposed traffic control standards, conducts special traffic and accident studies; and coordinates with Districts and other engineering sections.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Manager, Traffic Unit is responsible for and has the authority to perform or cause to be performed the following:

A. Supervises the work activities of personnel assigned to the Traffic Unit.

B. Directs and controls the preparation of plans and specifications for fabrication and erection of signs and minor sign structures, and installation and operation of traffic control devices.

C. Formulates and reviews policies, procedures, standards and specifications for the design, manufacture, and use of traffic control devices.

D. Conducts traffic research, and recommends improvements related to geometric design, traffic control and safety.

E. Develops project assignments for signing projects design.

F. Ensures accomplishment of all activities within specified time limits by altering work assignments to accommodate fluctuations in workload.

G. Provides review of the geometric design of road plans as related to traffic operation.

H. Develops and recommends the highway safety improvement program including the gathering of supporting data on accidents before and after an improvement.

POSITION GUIDE

MANAGER, TRAFFIC UNIT

Date Issued

III. RELATIONSHIPS

A. With the Supervisor, Engineering Services Section --

1. Reports to and is accountable to the Supervisor, Engineering Services Section for the proper interpretation and effective performance of his duties and responsibilities.

B. With other Divisions, Sections and Districts --

1. Develops and maintains close relationships to ensure that all factors are considered in decisions related to traffic movements.

C. With the Federal Highway Administration, other Agencies, Contractors and Suppliers --

2. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

POSITION GUIDE

MANAGER, HYDRAULICS UNIT

Date Issued

I. FUNCTION

The Manager, Hydraulics Unit directs and controls all major hydraulics design.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Manager, Hydraulics Unit is responsible for and has the authority to perform or cause to be performed the following:

A. Supervises the work activities of personnel assigned to the Hydraulics unit.

B. Directs and controls the preparation of plans and specifications for the design and use of major drainage and irrigation facilities.

C. Performs investigations, formulates and reviews policies, procedures, standards and specifications for the design, manufacture and use of all drainage, irrigation, and special feature facilities.

D. Develops project assignments for hydraulic design.

E. Ensure accomplishment of all activities within specified time limits by altering work assignments to accommodate fluctuations in workload.

F. Investiages and reports on the validity of landowner claims relative to hydraulic problems.

III. RELATIONSHIPS

A. With the Supervisor, Engineering Services Section --

1. Reports to and is accountable to the Supervisor, Engineering Services Section for the proper interpretation and effective performance of his duties and responsibilities.

B. With the Federal Highway Administration, other Agencies, Contractors and Suppliers--

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

POSITION GUIDE

MANAGER, HYDRAULICS UNIT

Date Issued

III. RELATIONSHIPS (continued)

C. With other Divisions, Sections and Districts --

1. Develops and maintains close relationships to ensure that all factors are considered in decisions relative to design of hydraulic installations.

POSITION GUIDE

MANAGER, ENVIRONMENTAL UNIT

Date Issued

I. FUNCTION

The Manager, Environmental Unit directs and controls the development of major landscape and beautification designs and prepares studies relative to general environmental services.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Manager, Environmental Unit is responsible for and has the authority to perform or cause to be performed the following:

A. Supervises the work activities of personnel assigned to the Environmental Unit.

B. Directs and controls the development of major landscape and beautification plans for all special roadway features.

C. Formulates and recommends policies, procedures, standards and specifications for seeding, planting and other measures required for landscape restorations and preservation.

D. Reviews the environmental statements developed in the Location and Road Design Section and recommends adjustments where required.

E. Provides guidance on the environmental effects of highway design as required on all projects.

F. Ensures accomplishment of all activities within specified time limits by altering work assignments to accommodate fluctuations in work load.

III. RELATIONSHIPS

A. With the Supervisor, Engineering Services Section --

1. Reports to and is accountable to the Supervisor, Engineering Services Section for the proper interpretation and effective performance of his duties and responsibilities.

III. RELATIONSHIPS (continued)

B. With the Administrator, Preconstruction Division --

1. In unusual circumstances of unresolved conflict with Road Design personnel, the Manager of the Environmental Unit may prepare memorandum reports or presentations for the direct review by the Administrator of the Preconstruction Division. This procedure will be followed only when the Manager of the Environmental Unit is convinced that Road Design plans endanger the environment and after he has exhausted all normal avenues for changing these plans.

C. With the Federal Highway Administration, other Agencies, Contractors and Suppliers --

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

D. With other Divisions, Sections and Districts --

1. Develops and maintains close relationships to ensure that all factors are considered in decisions relative to Environmental Services.

POSITION GUIDE

MANAGER, PHOTOGRAMMETRIC UNIT

Date Issued

I. FUNCTION

The Manager, Photogrammetric Unit administers the development of work schedules; development of flight controls; conduct of photogrammetric work; and coordination with the Districts, pilots and engineering sections.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Manager, Photogrammetric Unit is responsible for and has the authority to perform or cause to be performed the following:

A. Supervises the work activities of personnel assigned to the Photogrammetric Unit.

B. Plans and coordinates the obtaining of aerial photographs.

C. Plans and coordinates the necessary ground control required for aerial photography.

D. Prepares contour maps from aerial photographs with stereo plotters.

E. Conducts research and recommends improvements related to photogrammetric services.

F. Ensures accomplishment of all activities within specified time limits by altering work assignments to accommodate fluctuations in workload.

G. Recommends the type of general surveys to be conducted for specific projects.

H. Provides for the photogrammetric work relative to the finalization of construction projects.

III. RELATIONSHIPS

A. With the Supervisor, Engineering Services Section --

1. Reports to and is accountable to the Supervisor, Engineering Services Section for the proper interpretation and effective performance of his duties and responsibilities.

POSITION GUIDE

MANAGER, PHOTOGRAMMETRIC UNIT

Date Issued

III. RELATIONSHIPS (continued)

B. With the Chief pilot --

1. Coordinates work schedules in order to perform flights which meet project schedule requirements.

C. With the Supervisor, Photographic Section --

1. Coordinates work schedules in order to perform photogrammetric services and research which meet project requirements.

POSITION GUIDE

MANAGER, SURFACING UNIT

Date Issued

I. FUNCTION

The Manager, Surfacing Unit directs and controls the design of the structural sections required for surfacing of highway projects.

II. RESPONSIBILITY AND AUTHORITY

Within the limits of Department policy and in accordance with approved procedures, the Manager, Surfacing Unit is responsible for and has the authority to perform or cause to be performed the following:

A. Supervises the personnel assigned to the Surfacing Unit.

B. Directs and controls the preparation of proposed surfacing structural sections, recommends special provisions and specifications, and obtains approval of the structural sections from Department and Federal Highway Administration sources.

C. Administers and recommends policies and procedures with reagrd to the design of structural sections.

D. Compiles and analyzes information regarding surfacing material availability and maintains records for future reference.

E. Ensures accomplishment of all activities within specified time limts by altering work assignments to accommodate fluctuations in work load.

F. Coordinates the optioning of surfacing materials sources.

III. RELATIONSHIPS

A. With the Supervisor, Engineering Services Section --

1. Reports to and is accountable to the Supervisor, Engineering Services Section for the proper interpretation and effective performance of his duties and responsibilities.

B. With the Federal Highway Administration, other Agencies, Contractors and Suppliers--

1. Establishes and maintains those relationships which are in the best interest of the Department and are necessary for the accomplishment of his function.

POSITION GUIDE

MANAGER, SURFACING UNIT

Date Issued

III. RELATIONSHIPS (continued)

C. With other Divisions, Sections and District --

1. Develops and maintains close relationships to ensure that all factors are considered in decisions relative to surfacing design and materials sources.

CONTENTS

EXISTING SCHEDULING AND CONTROLLING SYSTEM

+ Example project status report
+ Results of the analyses of the existing scheduling and controlling system.

IMPROVED SCHEDULING AND CONTROLLING SYSTEM

+ Detailed procedures and forms developed for the revised scheduling and controlling system.

EXISTING SCHEDULING AND CONTROLLING SYSTEM

The following pages demonstrate the manner in which existing scheduling and controlling systems were evaluated.

The first sheet is an example of the existing Semi-Monthly Report of Status of Projects for Proposed Future Lettings. This report served as the primary data source for the analysis. Note the absence of a comparison between planned and actual progress in the report.

The following sheets indicate the results of the evaluation. Note especially the changing priorities and the status of project design.

EXAMPLE PROJECT STATUS REPORT

Form PC-177
(Revised 1/15/71)

MONTANA HIGHWAY DEPARTMENT
PROJECT CONTROL DIVISION

Report Date 11/20/71
Letting Date 4/72
Adv. Date

SEMI-MONTHLY REPORT OF STATUS OF PROJECTS FOR PROPOSED FUTURE LETTINGS

CONSTRUCTION PROJECT NO.	PE AGR. NO.	RW AGR. NO.	DESIGNATION	TYPE OF WORK	LENGTH	DIST.		STATUS OF PLANS			RW ACQ.	UTIL. AGRMTS.	LEGAL	DESIGNER
						F	A	RW	UTIL.	CONST.				
(1) @@I 94-1( )42	(3)(9)	---	(W.Section) Custer-E.& W.	GS,PMS	4.073	11	5	N.I.	N.I.	30%	N.I.	N.I.	N.I.	R.Williams
***I 94-2(18)60	(14)	(16)	Hysham-E.& W.	(Frontage Road) G,GS	1.0	11	5	100%	100%	100%	77%	N.I.		
***I 94-3( )76 U1	(17)	(19)	Rosebud Co.Line-E.	G,GS,PMS	7.158	12	5	100%	100%	99%	96%	N.I.		Consultant Design
I 94-3( )76 U2	(17)	(19)	Rosebud Co.Line-E.	Str. @ Sta. 1581+34.05	---	12	5	---	---	80%	---	---		
(1)###I 94-4( )127	(17)	(19)	Miles City-W.	G,GS,PMS,Strs.	8.238	12	5	100%	100%	90%	68%	N.I.		Ken R. White
(1)###EHS I 94-4( )127	---	---	Miles City-W.	Lights,Sfty.Corr. Comp.4 Lane	0.849	12	5	N.I.	N.I.	0%	N.I.	N.I.	N.I.	
(1) I 94-4( )136	(18)	(21)	Miles City-E.	G,GS,PMS,Strs.	10.939	12	5	100%	100%	85%	92%	3 of 3		Ken R. White
F 270(10) U90	(10)		Kalispell-No.	G,GS,PMS	0.530	1	1	0%	0%	51%	0%	0%		W.Nelson
EPS F 226( )			R.R.Underpass-E.Glacier	Traffic Impact Attenuator	---	2	3	N.I.	N.I.	0%	N.I.	N.I.	N.I.	
EHS F-RF 245( )	(12)	(22)	Savage-No.	G,GS,PMS,Strs.	1.484	4	4	100%	100%	72%	95%	5 of 6		S.Stoner
F-RF 256( )	(25)	(29)	Sand Springs-NE	G,GS,PMS,Br.	11.849	5	5	100%	100%	97%	98%	1 of 2		W.McCoskery
EHS F 9999( )	(46)	---	Garfield,Petroleum & Rosebud Cos.	Signs,Traffic Control Devices	189.2	5, 12	5	N.I.	N.I.	90%	N.I.	N.I.		
*FI 10( )	(7)	---	Great Falls-Vaughn	G,GS	8.3	6	3	N.I.	N.I.	0%	N.I.	N.I.		
EHS F 218( )	(15)	---	6th St.Underpass-Great Falls	Traffic Impact Attenuator	---	6	3	N.I.	N.I.	0%	N.I.	N.I.	N.I.	
@EMP F-RF 43( )	(26)	(27)	Divide I Conn.	G,GS,PMS	0.8	9	2	100%	100%	95%	84%	0 of 2		Consultant Design
EPS F 9999( )	(29)	---	Beaverhead,D.Lodge, Madison & S.Bow	Signs,Traffic Control Devices	127.6	9	2	N.I.	N.I.	95%	N.I.	N.I.		
@@@EMP F-RF 60( )	(13)	(14)	Wilsall-So.	G,GS,PMS	3.304	10	2	100%	100%	98%	99%	2 of 2		W.McCoskery
@@@EMP F 239( ) U1	(11)	(15)	Wilsall-NW	G,GS,PMS	5.689	10	2	100%	100%	97%	100%	1 of 1		W.McCoskery
EMP F 239( ) U2	(11)	(15)	Wilsall-NW	Str. @ Sta. 213+42.50	---	10	2	---	---	85%	---	---		
EHS F 9999( )			Carter,P.River & Rosebud Counties	Signs,Traffic Control Devices		12	5	N.I.	N.I.	0%	N.I.	N.I.		

STATUS OF CONTRACT PLAN PREPARATION
PROJECTS SCHEDULED FOR ADVERTISEMENT
AUGUST, 1970 THROUGH JUNE, 1971

Month Scheduled	No. of Projects	Range in Percent Completion	Average Percent Completion
1970:			
August	10	45% to 100%	82%
September	25	0 to 100	82
October	23	0 to 98	70
November	13	0 to 100	31
December	6	0 to 61	26
1971:			
January	10	0 to 98	35
February	4	0 to 5	3
March	11	0 to 90	56
April	11	0 to 91	37
May	15	0 to 90	33
June	7	0 to 90	39
Total	135	0% to 100%	
Weighted Average			55%

Source: Semi-monthly Report of Status of Projects for Proposed Future Lettings dated July 5, 1970

STATUS OF CONSTRUCTION PLANS PREPARATION
DISTRIBUTION OF PROJECTS
BY PERCENT OF DESIGN COMPLETED

July 5, 1970

MONTH SCHEDULED FOR ADVERTISEMENT	PERCENT DESIGN COMPLETED JULY 5, 1970							
	0%	1% to 25%	26% to 50%	51% to 75%	76% to 95%	96% to 99%	100%	Total
August:								
Number of Projects			2	1	4		3	10
Percent of Projects			20%	10%	40%		30%	100%
September:								
Number of Projects	1	2	2	2	9	4	5	25
Percent of Projects	4%	8%	8%	8%	36%	16%	20%	100%
October:								
Number of Projects	3		3	2	14	1		23
Percent of Projects	13%		13%	9%	61%	4%		100%
November:								
Number of Projects	4	3	1	3	1		1	13
Percent of Projects	30%	23%	8%	23%	8%		8%	100%
December:								
Number of Projects	2	2	1	1				6
Percent of Projects	33%	33%	17%	17%				100%
January:								
Number of Projects	4	2	1		2	1		10
Percent of Projects	40%	20%	10%		20%	10%		100%
Six Month Total:								
Number of Projects	14	9	10	9	30	6	9	87
Percent of Projects	16%	11%	11%	11%	34%	7%	10%	100%

STATUS OF ROAD DESIGN PROJECTS
BY SYSTEM AND MONTH
JULY, 1970 THROUGH JUNE, 1971

Month Advertisement Scheduled	INTERSTATE				PRIMARY AND SECONDARY			
	Department Design		Consultant Design		Department Design		Consultant Design	
	No. of Projects	Average % Complete	No. of Projects	Average % Complete	No. of Projects	Average % Complete	No. of Projects	Average % Complete
1970:								
July	1	100%	4	100%	14	100%	--	--
August	--	--	--	--	2	68	--	--
September	3	89	1	90	5	97	1	100%
October	2	70	6	79	6	89	--	--
November	1	75	--	--	4	67	--	--
December	1	61	--	--	1	50	--	--
1971:								
January	2	25	--	--	2	88	--	--
February	--	--	--	--	--	--	--	--
March	2	78	--	--	7	65	--	--
April	2	71	2	49	5	34	--	--
May	3	77	1	90	3	0	--	--
June	--	--	--	--	4	68	--	--
Total	17		14		53		1	
Weighted Average		72%		82%		74%		100%

SOURCE: Semi-Monthly Report of Status of Projects for Proposed Future Lettings, dated July 5, 1970

STATUS OF CONSTRUCTION DESIGN
FOR SELECTED SAMPLE OF ACCELERATED PROJECTS

January through August 1970

PROJECT TYPE	LENGTH	ADVERTISEMENT DATE			PERCENT COMPLETED	
		Schedule	Actual	Months Accelerated	Three Months Before Advertisement	One Month Before Advertisement
G, GS, PMS	3.0 miles	7-71	8-70	11	95% *	100% 2/
G, GS, PMS, Str.	7.0 miles	4-71	8-70	8	95%	100% 1/
G, GS, PMS, Str.	5.1 miles	9-71	7-70	14	90%	100% 1/
GS, PMS, Str.	9.2 miles	11-71	6-70	17	80%	95% 1/
GS, PMS	11.4 miles	1-71	4-70	8	90%	98% 1/
G	0.8 mile	8-71	3-70	17	90% **	90% 2/
GS, PMS	0.8 mile	7-72	3-70	28	90% **	90% 2/
G, GS, PMS, Str.	0.5 mile	11-72	3-70	32	***	100% 2/

* Not reported. Status of design two months prior to advertisement was 95%.
** Not reported. Status of design two months prior to advertisement was 90%.
*** Not reported.
1/ Design by Consultants.
2/ Design by Department.

Sources: Scheduled advertisement dates from Tentative Construction Program 1970-1974.
Percent construction design completed from Semi-Monthly Report of Status of Projects For Future Lettings.

STATUS OF CONSTRUCTION DESIGN
FOR SELECTED SAMPLE OF DELAYED PROJECTS

January through August 1970

PROJECT TYPE	LENGTH OF PROJECT	ADVERTISEMENT DATE			PERCENT COMPLETED	
		Scheduled	Actual or (Reschedule)	Months Delay	One Month Before Schedule Date	Schedule Date
G, GS, PMB	5.5 miles	7-70	(9-70)	2	98%	98%
G, GS, PMB	5.5 miles	7-70	(10-70)	(3)	95%	95%
G, GS, PMS	9.3 miles	3-70	6-70	3	98%	99%
G, GS, PMB	8.0 miles	7-70	(10-70)	(3)	70%	90%
G, GS, PMB	7.8 miles	7-70	(1-71)	(6)	90%	95%
G, GS, PMB	9.0 miles	7-70	(11-70)	(4)	90%	90%
G, GS, Br.	8.0 miles	7-70	(7-71)	(12)	35%	35%
G, GS, PMS	8.3 miles	6-70	(9-70)	(3)	98%	98%
G, Str., F	11.4 miles	3-70	(1-71)	(10)	90%	98%
G, GS, PMS, Str.	13.5 miles	3-70	8-70	5	92%	95%
G, GS, PMS, Strs.	9.0 miles	2-70	3-70	1	98%	100%
PMS, Str.	12.2 miles	7-70	8-70	1	86%	100%
G, GS	13.0 miles	4-70	9-70	5	98%	98%
AVERAGES	9.3 miles			4	88%	92%

Sources: Scheduled advertisement dates from Montana Highway Commission Tentative Construction Program 1970-1974.
Percent construction design completed from Semi-Monthly Report of Status of Projects for Future Lettings.

IMPROVED SCHEDULING AND CONTROLLING SYSTEM

The scheduling and controlling system developed during the project is shown on the following pages. The material presented is the scheduling and evaluation section of the Design Management Manual. The system is divided into four major elements. These are:

1. The controlling network
2. Feasibility scheduling
3. Detailed scheduling
4. Work control and progress evaluations.

SYSTEM COVERAGE

The scheduling and evaluating system described in this section of the appendix covers Road Design personnel in the following personnel classifications:

Technician I
Technician II
Technician III
Senior Technician
Project Manager
Project Engineer
Senior Manager
Senior Engineer

Organization units covered by the system include the following:

Central Internal Design Units
Field Design Units

Road Design units not covered by the system, at least initially, are:

Consultant Design
Contract Plans
Traffic
Hydraulics
Environmental
Photogrammetrics
Surfacing

Road Design personnel in covered units and covered personnel classifications prepare and submit reports in accordance with the procedures described herein.

SYSTEM DESCRIPTION AND PROCEDURES

The scheduling and progress evaluation system has four major parts. These parts are (1) the controlling network, (2) stage one scheduling, (3) stage two scheduling, and (4) progress evaluations.

CONTROLLING NETWORK

The previous section in this manual describes a complete road design network, which has over 200 tasks. That network gives road design personnel a comprehensive check list. It describes the sequence in which work is done. It shows which tasks are interdependent and those that must be completed before others can be started. It provides designers with detailed guidance for their day-to-day work, but it is too complex for scheduling and progress evaluations. A summary network is needed for these purposes.

Figure 1 shows the summary activity network developed for road design. The network has about 50 activities, 11 preconstruction milestone events and two project control dates.

Project Control Dates

The two project control dates are project start (PR-1 approval) and contract letting. These dates are top management's expression of the Department's objectives and priorities. They are established in the five year program.

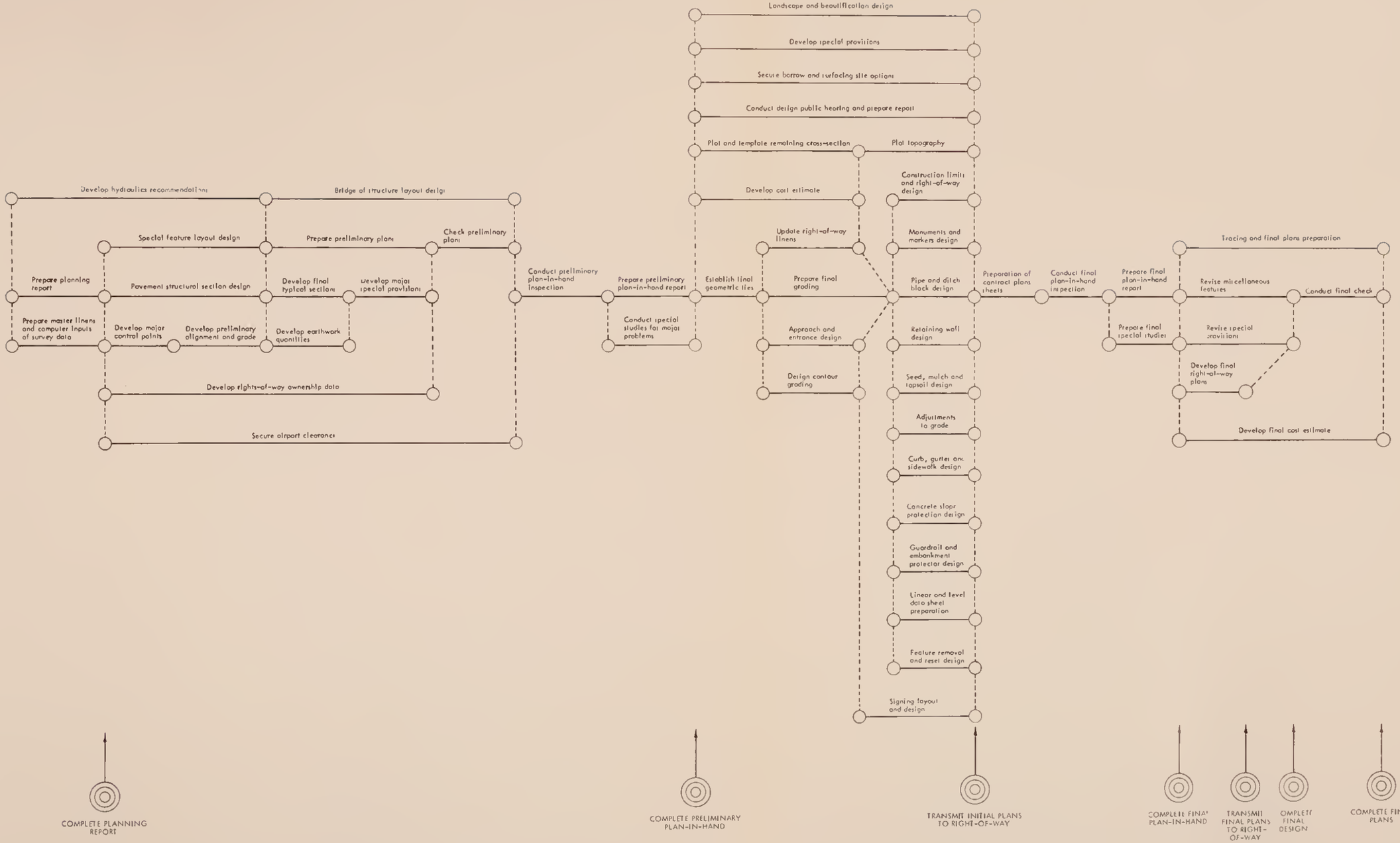
Milestone Events

A milestone event is an objective established within the activity network. It is a major project progress check point.

Figure 6

ROAD DESIGN

SUMMARY ACTIVITY NETWORK


Develop hydraulics recommendations
Bridge structure layout design
Special feature layout design
Prepare preliminary plans
Check preliminary plans
Prepare planning report
Pavement structural section design
Develop final typical sections
Develop major special provisions
Prepare master lines and computer inputs of survey data
Develop major control points
Develop preliminary alignment and grade
Develop earthwork quantities
Develop rights-of-way ownership data
Secure airport clearance
Conduct preliminary plan-in-hand inspection
Prepare preliminary plan-in-hand report
Conduct special studies for major problems
Establish final geometric ties
Landscape and beautification design
Develop special provisions
Secure borrow and surfacing site options
Conduct design public hearing and prepare report
Plot and template remaining cross-section
Plot topography
Develop cost estimate
Construction limits and right-of-way design
Update right-of-way lines
Monuments and markers design
Prepare final grading
Pipe and ditch block design
Approach and entrance design
Retaining wall design
Design contour grading
Seed, mulch and topsoil design
Adjustments to grade
Curb, gutter and sidewalk design
Concrete slope protection design
Guardrail and embankment protector design
Linear and level data sheet preparation
Feature removal and reset design
Signing layout and design
Preparation of contract plans sheets
Conduct final plan-in-hand inspection
Prepare final plan-in-hand report
Prepare final special studies
Tracing and final plans preparation
Revise miscellaneous features
Conduct final check
Revise special provisions
Develop final right-of-way plans
Develop final cost estimate
COMPLETE PLANNING REPORT
COMPLETE PRELIMINARY PLAN-IN-HAND
TRANSMIT INITIAL PLANS TO RIGHT-OF-WAY
COMPLETE FINAL PLAN-IN-HAND
TRANSMIT FINAL PLANS TO RIGHT-OF-WAY
COMPLETE FINAL DESIGN
COMPLETE FINAL PLANS
ROAD DESIGN MILESTONE EVENTS

Note. There is no relationship between the amount of time required to perform an activity and the length of the activity line in the activity network.

There are eleven milestone events, of which seven are the direct responsibility of Road Design. The other four events describe deadlines which influence Road Design scheduling. The milestones are as follows:

PROJECT PLANNING MILESTONES:

- Complete Reconnaissance Studies and/or Mapping
- Complete Location Report
- Complete Field Surveys

DIRECT ROAD DESIGN MILESTONES:

- Complete Planning Report
- Complete Preliminary Plan-In-Hand
- Transmit Initial Plans to Right-of-Way
- Complete Final Plan-In-Hand
- Transmit Final Plans to Right-of-Way
- Complete Final Design
- Complete Final Plans

PRECONSTRUCTION COORDINATED MILESTONE:

- Transmit Plans to Contract Plans Section

Note that each milestone event is the completion of a major segment of a project. Completion dates can and will be established for each milestone event. Project progress will be measured by the timing of the completion of these events.

Activities

Activities span time and require work. The completion of an activity, or a series of activities is an event. Examples of activities are prepare planning, report, develop final typical sections, and conduct preliminary plan-in-hand inspections.

Activities are used to (1) report what work is underway, (2) report the current status of work; and (3) establish month-by-month road design objectives to ensure completion within project control dates and milestone events.

STAGE ONE SCHEDULING

The first stage of the scheduling system requires two steps -- (1) the initial establishment of milestone control dates, and (2) the decision that the resulting initial schedule is realistic.

Milestone Dates

Form SE-1, Milestone Dates, will be completed for each project to be designed by the Department, if the project is currently active or to be started within the five years covered by the approved program. An example of the Milestone Dates form is shown in Figure 2.

The procedures for establishing the milestone dates are as follows:

1. The Location and Road Design Supervisor, in consultation with Senior Supervisors (Area Engineers), establishes milestone dates and design assignments for each project.

    + Dates assigned will be within approved project control dates.
    + Field (division or district) design responsibilities will be made in the same manner as those for the Central Office.
    + Coding used on the form will be in accordance with coding instructions shown in Figure 2A.

2. The Location and Road Design Supervisor sends the completed SE-1 (Milestone Dates Form) to Data Processing. He requests that they prepare two trial output reports -- the Milestone Summary, form SE-2, and the Surveys Deadlines, form SE-3. (Examples of these reports are shown in Figures 3 and 4.) He also requests the return of forms SE-1 after key punching has been completed.

Figure 2

SE-1

MILESTONE DATES

Project Description:

Number _____ Linear Length _____

Type _____ Location _____

Project Control Dates:	Approved Program	Revised Program
Preconstruction Starts (PR-1 approval)	_____	_____
Contract Letting Date	_____	_____

Revision Justification:

_____

_____

_____

_____

Revision Approved _____ _____

(State Highway Engineer) (Date)

****

Milestone Dates:

Complete Recon. Studies and/or Mapping _____

Complete Location Report _____

Complete Field Surveys _____

Complete Planning Report _____

Complete P.P.I.H. _____

Transmit Initial Plans to Right-of-Way _____

Complete F.P.I.H. _____

Transmit Final Plans to Right-of-Way _____

Complete Final Design _____

Complete Final Plans _____

Transmit to Contract Plans _____

Project Assignments:

Field Survey _____ _____
(Division) (no.)

Senior Road Design Supervisor _____ _____
(name) (no.)

Project Road Design Supervisor _____ _____
(name) (no.)

Approvals:

_____ _____
(Road Design Engineer) (date)

_____ _____
(A.S.H.E. - Preconstruction) (date)

_____ _____
(Field Survey by A.S.H.E. - Operations) (date)

Figure 2A

CODING INSTRUCTIONS

MILESTONE DATES

Form SE-1

Project Description:

Number -- Use the accounting code number for the project. This is the same number used on time sheets.

Linear Length -- Show the linear length of the project to the nearest tenth of a mile.

Type -- Show project type (grading, plant mix base, plant mix surfacing, etc.) using the normal abbreviation system (gr, pmb, pms). You may not exceed 20 characters in this space.

Location -- Briefly describe project location. You may not exceed 20 characters in this space.

Project Control Dates:

Month and Year are ta be shown.

Milestone Dates:

Month and Year are ta be shown.

Project Assignments:

Field Survey -- Show name and four digit number normally used for the Division.

Senior Road Design Supervisar -- Shaw name and one digit number. A unique number is assigned each Senior Supervisor. If design is to be done by a Divisian, show the location in the name blank and the four digit division number.

Project Road Design Supervisor -- Show name and unique two digit number. This space is blank if design is to be prepared in the field.

****

Numbering Example

	--Numbers Assigned--		
Senior Supervisors	1	2	3
Project Supervisors	11	21	31
	12	22	32
	13	23	33

Figure 3

SE-2

ROAD DESIGN
MILESTONE SUMMARY
BY PROJECT SUPERVISOR

Senior Supervisor _____ Report Date _____

Project Supervisor _____

Project Description Number / Location	Type / Length	Milestone Element	Milestone Complete Date	Working Days In Period	Current Year (By Month) J F M A M J J A S O N D	Current Year + 1 (By Month) J F M A M J J A S O N D	Current Year + 2 (By Month) J F M A M J J A S O N D	Current Year + 3 (By Quarter) 1 2 3 4	Current Year + 4 (By Quarter) 1 2 3 4

Figure 4

SE-3

COMPLETION DEADLINES
FIELD SURVEYS

Division _____ Schedule Date _____

Progress Report for Month Ended _____

Project Description				Scheduled Completion		Percent Complete			
						Field Survey		Soils Survey	
Number	Type	Length	Location	PR-1 Approval	Field and Soils Survey	Month	Total To Date	Month	Total To Date

3. Upon receipt of the trial Milestone Summary and Surveys Deadlines reports the Location and Road Design Supervisor reviews projected work loads to determine if they are reasonable. If revisions are necessary, within project control dates, they are made by (1) changing the Milestone Dates Forms, if new computer runs are desired or (2) by mark-up of the output reports.

   + The Location and Road Design Supervisor may request as many trial runs from data processing as he feels necessary to establish a reasonable program.

   + If more senior supervisors or project supervisors are expected to be needed to meet future work-loads, the name will be left blank on the SE-1 and a fictitious man number will be assigned for each new project supervisor or senior supervisor anticipated for the future.

4. If schedule revisions, beyond the authority of the Location and Road Design Supervisor, appear necessary he will prepare a recommended plan of action.

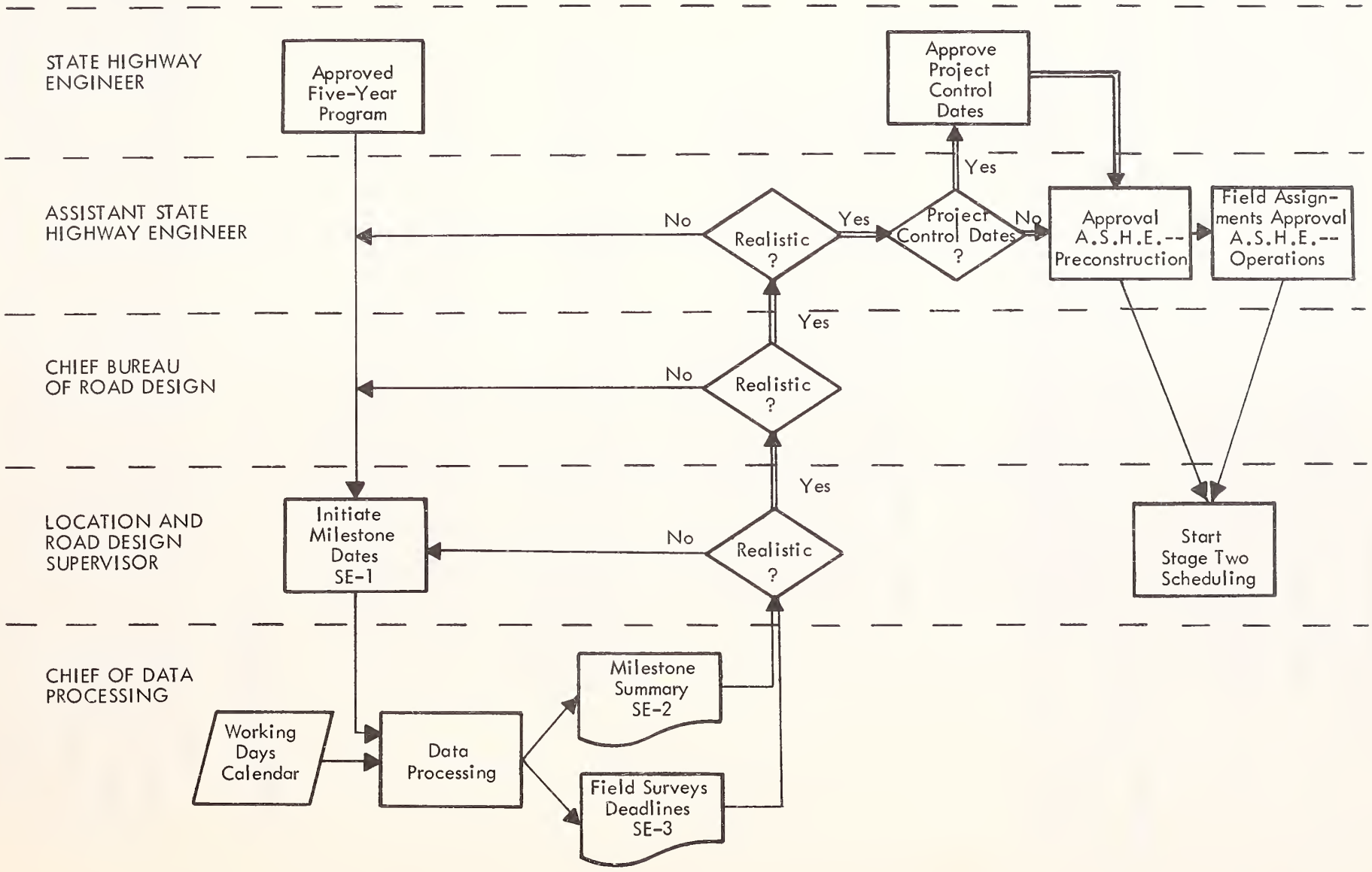
   + Recommended actions at this point will be limited to revision of project control dates and / or expansion or reduction in the number of senior or project supervisors.

Review and Approval

Upon completion of a realistic schedule the Location and Road Design Supervisor will present the recommended program to the Chief Bureau of Road Design. Appropriate adjustments will be made and further trial projections will be prepared by Data Processing, if required. Particular attention will be directed to proposed changes in project control dates and changes in the number of senior or project supervisors.

Figure 5

STAGE ONE SCHEDULING
MANAGEMENT FLOW CHART



Upon completion of the review, the Chief Bureau of Road Design will sign the Milestone Dates form for each project and recommend the program to the Assistant State Highway Engineers for Preconstruction and Operations for their approval. If revisions in project control dates are necessary they will be presented to the State Highway Engineer for approval. Upon receipt of necessary approvals stage one of the scheduling process is completed. The Location and Road Design Supervisor will then re-submit all changed Milestone Dates, form SE-1, to data processing advising them that initial scheduling has been completed. Upon completion of key punching of revised SE-1 forms they will be returned to Road Design.

Timing

Stage one scheduling will be repeated (1) each time it becomes apparent that milestone dates will not be met, (2) when project priorities change and revised milestone completion dates are desired, (3) once each year to coincide with budget development or review, and (4) to coincide with the review of the five year plan. The rescheduling may be as broad or as narrow as is required by circumstances. It may be one project or all projects.

A flow chart summarizing stage one scheduling is shown in Figure 5.

Figure 6

SE-4

PROJECT CHARACTERISTICS

Project Number _____ Date _____

System: Interstate ☐ Primary ☐ Secondary ☐ Urban ☐

Length:

Project Linear Length	_____	miles
Add:		
Length of Split Alignment for Multi-Lane Projects	_____	miles
Total Adjusted Road Design Length	_____	miles

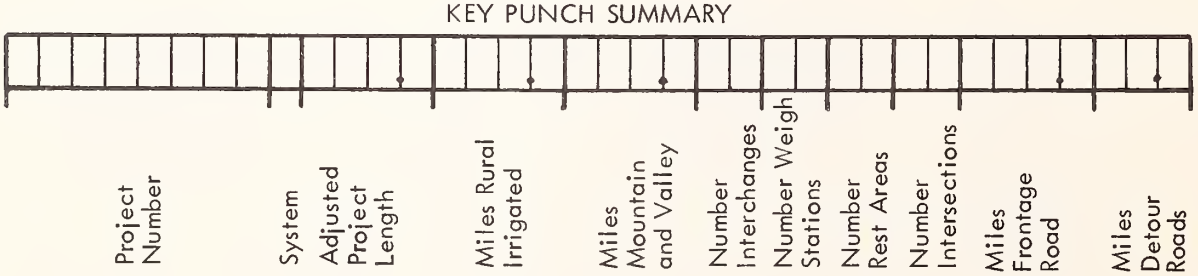
Culture and Terrain:

Rural Irrigated	_____	miles
Mountainous and Valley	_____	miles

Special Features:

Interchange(s)	_____	number
Weigh Station(s)	_____	number
Rest Area(s)	_____	number
Major Intersection(s)	_____	number
Frontage Road(s)	_____	miles
Detour Road(s)	_____	miles

KEY PUNCH SUMMARY



STAGE TWO SCHEDULING

Stage two scheduling requires four steps -- (1) definition of project characteristics, (2) establishment of monthly road design objectives, (3) review of the resultant five year manpower plan and budget, and (4) the determination that the proposed program is reasonable as scheduled.

Project Characteristics

Form SE-4, Project Characteristics, is completed for each scheduled project. Its purpose is to provide data processing with definition of variables that control the number of man-hours that will be planned for each project. An example of the form is shown in Figure 6.

The form is initiated by the project supervisor to whom the project is assigned and reviewed and approved by the senior supervisor prior to transmittal to data processing. It should be updated whenever any of the characteristics shown on the form change.

Completion Objectives

Road designers (project supervisors) and senior supervisors (Area Engineers) establish monthly progress objectives that will allow them to complete their assignments within established milestone and project control dates. The completion objectives are documented on form SE-5 -- Completion Objectives by Milestone and Work Activity. This form is preprinted with all Road Design milestones and activities. It is completed for all projects active during the five year program period (an example is shown in Figure 7).

Not all activities will be required on all projects. The first step in completing the form, is to red line all milestones and work activities which do not apply to the project at hand. This step should be compatible with milestone decisions previously made. But, in the event that certain activities apply to a project -- and the milestone does not -- the completion objectives should be established for all required activities. This will ensure the allowance of the normal manpower time in manpower estimates.

Figure 7

SE-5

COMPLETION OBJECTIVES

BY MILESTONES AND WORK ACTIVITY

Project Number ☐☐☐☐☐☐☐☐

Project Supervisor _____ ☐☐

Senior Supervisor _____ ☐☐

Date Scheduled _____

MILESTONES AND WORK ACTIVITIES		SCHEDULED PERCENT COMPLETION BY MILESTONE AND WORK ACTIVITY																											
		Current Year (By Month)												Current Year + 1 (By Month)												Current Year + 2 (By Quarter)				Current Year + 3 (By Quarter)				Current Year + 4 (By Quarter)			
Name	Code	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	1	2	3	4	1	2	3	4	1	2	3	4
Complete Planning Report																																					
Prepare planning report	1																																				
Prepare master linens and computer inputs of survey data	2																																				
Complete Preliminary Plan-In-Hand																																					
Special feature layout design	3																																				
Pavement structural section design	4																																				
Develop major control points	5																																				
Develop right-of-way ownership data	6																																				
Secure airport clearance	7																																				
Develop hydraulics recommendations	11																																				
Develop preliminary alignment and grade	12																																				
Bridge or structure layout design	13																																				
Develop earthwork quantities	14																																				

The next step in the completion of this form is the plotting of objectives by activity. This is done by month for the first two years of the scheduling period and by quarter for each of the remaining three years.

Once an activity is commenced the objectives are to be posted, by estimated percent complete, for each activity for the reporting period. For example, if work commences on the development of preliminary alignment and grade in February and is to be completed in June, the schedules should show an estimated percent completion for each month that work is underway. In the example it could look like this:

MILESTONES AND WORK ACTIVITIES	SCHEDULED PERCENT COMPLETION BY MILESTONE AND WORK ACTIVITY							
	Code	J	F	M	A	M	J	J
Develop preliminary alignment and grade	12		40	40	60	80	100	

Project progress will be measured against these estimates and milestone objectives.

> Note: There may be a tendency to underestimate percentage completion to insure performance within objective dates. Don't. Estimated manpower requirements are also geared to these objectives. Underestimating the percentage completion will make it appear that more manpower is being used than should be used. Show your best estimate for each project.

Objectives established by project and senior supervisors will be reviewed and approved by the Location and Road Design Supervisor prior to their transmittal to data processing. The Location and Road Design Supervisor will ensure that schedules developed will allow attainment of milestones within the time period allowed in approved schedules.

Figure 8

SE-6

FIVE YEAR

MANPOWER PLAN AND BUDGET REPORT

Date Printed _____

---- ACTUAL ---- ----------ESTIMATED----------

PROJECT NUMBER	ESTIMATED TOTAL LABOR		TOTAL TO 6-30 PY		CURRENT FISCAL YEAR		C.Y. + 1		C.Y. + 2		C.Y. + 3		C.Y. + 4	
	Man-Years	Costs	Man-Years	Costs	Man-Years	Costs	Man-Years	Costs	Man-Years	Costs	Man-Years	Costs	Man-Years	Costs
TOTAL														
RECAP:														
Technician I														
Technician II														
Technician III														
Senior Technician														
Project Supervisors														
TOTAL														

Five Year Manpower Plan and Budget

Based on the scheduling done in stages I and II a five year manpower plan and budget will be developed by Data Processing, a copy of which is shown in Figure 8. It will be transmitted to the Location and Road Design Supervisor by data processing. He will review the report and determine if it (1) meets project control dates, (2) meets approved milestone dates, (3) is realistic, and (4) is within approved budgets. If any of these criteria are not met he will explore rescheduling within approved programs. This may be accomplished by revising completion objectives or repeating stage I and stage II rescheduling.

If all criteria are met the Location and Road Design Supervisor will recommend the program to the Chief Bureau of Road Design. The program is approved for execution upon the review and approval by the Chief Bureau of Road Design.

If approved programs and budgets can not be met the Location and Road Design Supervisor will prepare a preliminary plan. The plan will consider (1) revising milestone dates, (2) increasing or decreasing staff, (3) assigning design work to consultants, and (4) revising project control dates.

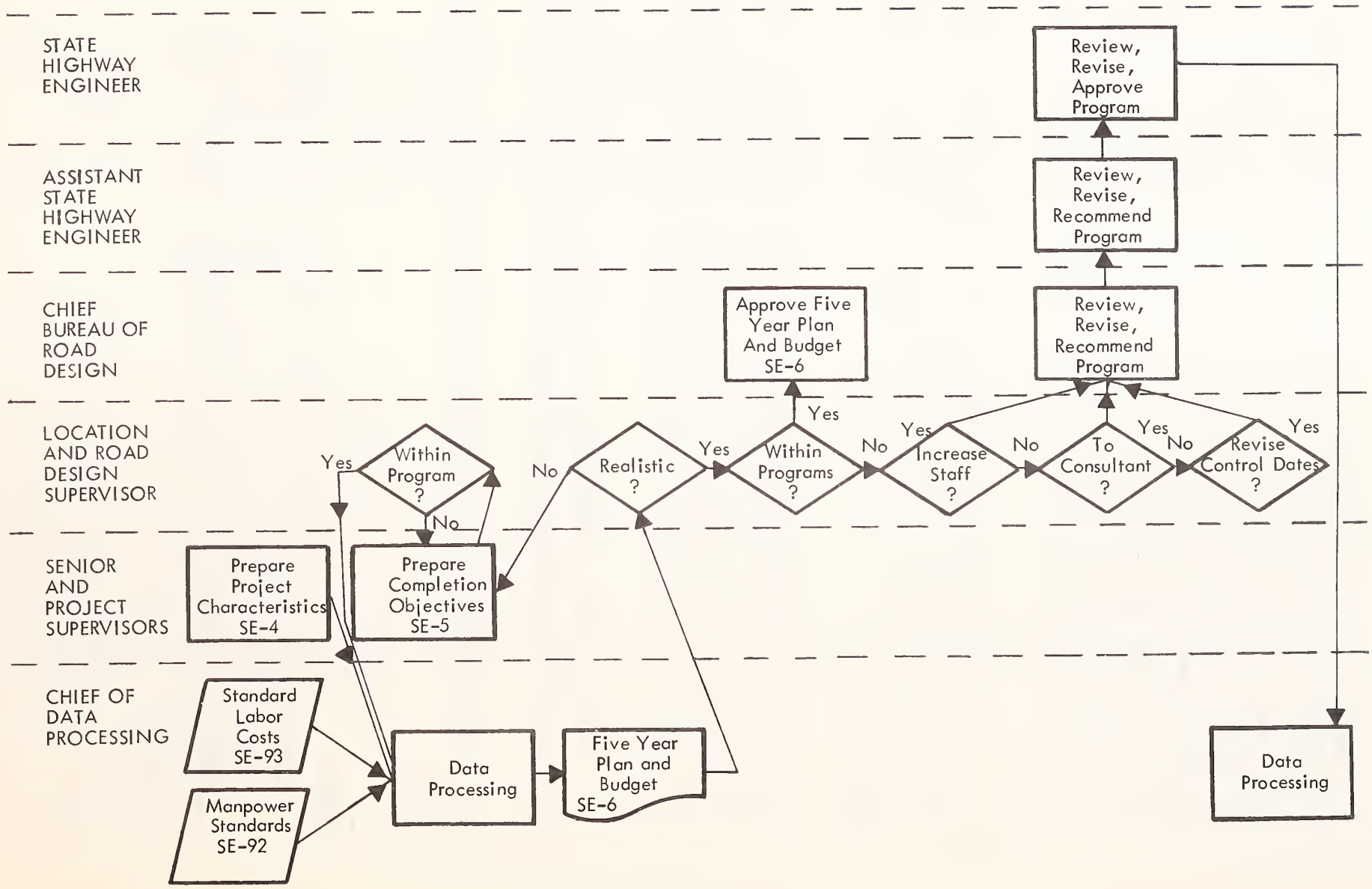
The Chief Bureau of Road Design will review the initial plan, revise it as necessary and recommend it to the appropriate authority level for approval.

Figure 9 is a summary of stage two scheduling procedures by responsibility level.

NOTE: This system provides estimates of time and costs for persons up through the project supervisor level. Time and cost estimates for persons in the Senior level positions are not made. Time they have spent on the past on direct project activities, such as the preparation of planning reports, is shown, however.

Figure 9

STAGE TWO SCHEDULING
MANAGEMENT FLOW CHART



PROGRESS EVALUATIONS

The progress evaluations (controlling) portion of the road design management system is made up of three manual input reports and four periodic output reports,

The manual input reports are:

1. Weekly Time Sheet, SE-7
2. Monthly Objectives and Status of Road Design, SE-8
3. Completion Deadlines for Field Surveys, SE-3.

The five output reports are:

1. Monthly Objectives and Status of Road Design, SE-8
2. Status Report, SE-9
3. Missed Milestones Report, SE-10
4. Manpower Control Report, SE-11
5. Budget Analysis Report, SE -12

Two of these reports -- Monthly Objectives and Status of Road Design, SE-8, and Completion Deadlines for Field Surveys, SE-3 -- are both output and input reports. The computer prints scheduled progress. Then persons doing the work put actual progress on the same form and re-submit it to Data Processing.

Each of these reports is discussed in detail below.

Weekly Time Sheet

The Weekly Time Sheet, form SE-7, is prepared by each employee in Road Design each week. A copy of the form to be used is shown in Figure 10.

The employee identifies the hours he worked, or was on leave, by project number and activity code. The project number to be used is the same numbering system currently used on payroll sheets. But the activity code is new. Figure 11 is a complete summary of the activity codes to be used in identifying the work performed on each project. There is an activity name, code, and explanation in Figure 11 for each activity that is shown in the controlling network.

Figure 10

SE - 7

WEEKLY TIME SHEET

Name _____ Man No. [ ]

Personnel Classification _____ Class No. [ ]

Period Beginning Saturday [ ] [ ] [ ]
Mo. Day Year

Project Number	Activity Code	TIME CHARGED IN HOURS							Total Regular	Total Overtime	Total Hours
		Sat.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.			
TOTAL HOURS											

Each employee is responsible for posting his own time sheet. Time sheets will be posted at least daily, and they will be turned in to project or senior supervisors before noon on the Monday following the close of the report period.

Senior supervisors will check through the weekly time sheets to see that they have been properly completed and to ensure that each employee has turned in his time sheet. The time sheets are then batched and transmitted to Data Processing for key punching. Data Processing will retain the time sheets for 30 days. If no questions have arisen they will then be destroyed.

NOTE: Road Design personnel will make two time sheets. The first, the one currently being prepared for payroll purposes, will continue to be prepared in accordance with the instructions issued by Accounting. The second, the Weekly Time Sheet form SE-7, will be prepared in accordance with the instructions in this manual.

Figure 11

ACTIVITY DESCRIPTIONS

FOR WORK REPORTING

ACTIVITY		TASKS INCLUDED IN ACTIVITY
Code	Description	
1	Prepare planning report	Transmit bridge separation data to Bridge Division Request and receive special soils or materials data from Materials Division Transmit sketch maps to Planning and Survey Division Request and receive traffic data Request and receive cost estimate from Right-of-Way Division for special problems Field review by design personnel Assemble data and write draft of planning report Distribute planning report draft Resolve problems and write final planning report
2	Prepare master linens and computer inputs of survey data	Trace hardshell data on linens Check survey notes for adequacy and accuracy Develop title sheet master Check linens against survey notes Request notes punching and grade line reduction run Verify punched cards for distribution and elevation of cross-sections Receive ground line elevation reduction printout
3	Special feature layout design	Consult geometric crew on special traffic conditions Design plan and profile for interchanges and special features Transmit geometric data to FHWA for comments Receive comments and revise as necessary
4	Pavement structural section design	Request and receive preliminary structural sections Request and receive comments and revise as necessary Receive notice of approval of structural sections from FHWA

Figure 11
Activity Description

ACTIVITY		TASKS INCLUDED IN ACTIVITY
Code	Description	
5	Develop major control points	Request and receive additional survey data if required by centerline projection Establish major control points, if centerline is projected
6	Develop right-of-way ownership data	Prepare right-of-way masters from linens Draft ownership information on brown line prints Request right-of-way estimates for economic analysis of IG split
7	Secure airport clearance	Request airport clearance from the FAA through the FHWA.
11	Develop hydraulics recommendations	Request, receive and analyze major drainage recommendations from Hydraulics Section
12	Develop preliminary alignment and grade	Request and receive "halo" run for equivalent stationing and horizontal offset Request and receive line shift and ground line elevation reduction rung Hand plot ground line for selected cross-sections Template cross-sections controlling grade, alignment or hydraulics Develop data processing inputs for preliminary earthwork quantity run Request and receive preliminary earthwork quantity run from Data Processing Division Transmit proposed grade line and typical section to Bridge Division Request and receive preliminary bridge ends and changes from Bridge Division
13	Bridge or structure layout design	Request and receive general layout and recommendations from Bridge Division
14	Develop earthwork quantities	Develop data processing inputs for final earthwork run Request and receive earthwork run from data processing Optimize the grade
15	Develop final typical sections	Design mainline and other necessary typical sections

Figure 11
Activity Description

ACTIVITY		TASKS INCLUDED IN ACTIVITY
Code	Description	
16	Develop major special provisions	Develop preliminary special provisions for sub-excavation, surcharge and traffic control during construction
17	Prepare preliminary plans	Plot pipe information for preliminary plan-in-hand Request and receive computer plotted cross-sections to one-half scale Prepare one page mass diagram and summarize grading Plot preliminary grades on linens Develop economic analysis of IG splits and project length characteristics
21	Check preliminary plans	Check preliminary plans for adequacy
22	Conduct preliminary plan-in- hand inspection	Establish inspection date with district and FHWA Request and receive reduction of preliminary plans Prepare cover letter and distribute plans Conduct office and field review in the field
23	Prepare preliminary plan-in-hand report	Obtain decisions on points of conflict Write preliminary plan-in-hand report Distribute report and request comments Resolve remaining points of conflict Finalize preliminary plan-in-hand report
24	Conduct special studies for major problems	Determine the need for special studies Request and receive specialized assistance as needed Develop solutions Request and receive approval for solutions
25	Landscape and beautification design	Request landscape and beautification layouts from Environmental Unit Review quality and quantity of water data received from Materials Division Request and receive water studies for changed locations from Materials Division Receive or design plans and layouts

Figure 11
Activity Description

ACTIVITY		TASKS INCLUDED IN ACTIVITY
Code	Description	
26	Develop special provision	Develop all special provisions Transmit to Contract Plans Unit Receive and review summaries of special provisions
27	Develop cost estimate	Develop cost estimate for major construction items Transmit cost estimate to project control
31	Plot and template remaining cross-section	Plot and ink remaining cross-sections Template cross-sections
32	Secure borrow and surfacing site options	Request and receive borrow and materials site data, if required, from district Request Right-of-Way Division to option pits
33	Establish final geometric ties	Tie geometrics of special features to alignment and grade of mainline Establish major control points of mainline and special features Request, receive and verify "halo" run for equivalent stationing and horizontal offset
34	Approach and entrance design	Determine approach location Determine approach grade Determine length and turning radius of approach Review major layouts with Traffic Unit Prepare notes and place on cross-sections
35	Prepare final grading	Compute quantities for special features or large additional excavations Balance the earthwork quantities in the project Adjust grade of mainline for economic haul Prepare one page mass diagram to show haul Request and receive final bridge layout from Bridge Division
36	Update right-of-way linens	Transmit construction units to right-of-way crew Request and receive right-of-way linens

Figure 11
Activity Description

ACTIVITY		TASKS INCLUDED IN ACTIVITY
Code	Description	
37	Design contour grading	Determine controlling contour elevations Determine two foot contour elevations
41	Signing layout and design	Obtain print of construction plans Request and receive final signing and electrical plans
42	Seed, mulch and topsoil design	Determine need for and availability of topsoil Identify slopes steeper than $1\frac{1}{2}$ to 1. Complete computer inputs and request and receive topsoil run Determine acreages and topsoil requirements Determine type and quantity of seed Determine type and quantity of mulch Request assistance from Environmental Unit on special problems
43	Retaining wall design	Develop justification Determine type-metal, wood, coverette Establish grade line for base of wall Template feature on cross-section Determine location and height of wall Design layout Compute backfill and quantities Place notes on cross-section and plan and profile Request and receive special data
44	Grade adjustments	Determine location of features to be adjusted to grade Determine elevation for each feature Place notes on plans
45	Curb, gutter and sidewalk design	Determine need for and length of curbing and sidewalks Determine location of lay-down curb Develop designs for curb, gutter and sidewalk Place notes on plan and profile

Figure 11
Activity Description

ACTIVITY		TASKS INCLUDED IN ACTIVITY
Code	Description	
46	Concrete slope protection design	Determine locations of concrete slope protection Obtain structure layout from Bridge Division Determine elevation and length of structure Develop materials quantities Place notes on cross-section and profiles
47	Guardrail and embankment protector design	Review design speed and projected ADT Develop guardrail warrant values and paint values, and plot Determine length of main sections and end sections Check for minimum length Plot station limits and place note on profile Determine additional surfacing for guardrail widening Determine embankment protector location and length of bituminous curb Design protector, write note on cross-section and plot note on plan and profile
51	Linear and level data sheet preparation	Develop data sheet
52	Pipe and ditch block design	Establish flow line elevation and grade line of pipe Determine drainage area for pipe and ditch block placement Design ditch block location and quantities Determine if pipe is skewed or to right angle of centerline Determine type of end section, and class, gage and length of pipe Design bedding, concrete cutoff walls, edge protectors and rip rap Determine culvert excavation Place pipe notes on cross-sections Place notes on plan and profile and plot hydraulics data on profile
53	Feature removal and reset design	Determine features, current locations and reset Place notes on plans

Figure 11
Activity Description

ACTIVITY		TASKS INCLUDED IN ACTIVITY
Code	Description	
54	Construction and right-of-way limits design	Plot construction limits on right-of-way linens Transmit right-of-way linens to right-of-way crew Request and receive right-of-way limits from right-of-way crew
55	Monuments and markers design	Determine location of markers and monuments Plot location on right-of-way prints
56	Plot topography	Plot major topography on cross-sections
57	Conduct design public hearing and prepare report	Develop display material and environmental statement Advertise and conduct public hearing Transmit report and advertise "request for approval" Develop or revise design study report Resolve problems and receive FHWA approval Advertise notice of approval
61	Preparation of contract plans sheets	Develop or update all quantity summaries Update title sheet and develop initial table of contents Develop general notes sheet and typical section sheets Prepare summary frames Obtain detail sheets including standard drawings Receive completed parks and recreation form Transmit major utility items to Utility Unit for preliminary contract
62	Conduct final plan-in-hand inspection	Establish date with district and FHWA Secure prints of all plans and transmit with cover letter Transmit irrigation estimate to Right-of-Way Division Conduct office and field review in the field
63	Prepare final plan-in-hand report	Obtain decisions on points of conflict Develop and revise report

Figure 11
Activity Descriptions

ACTIVITY		TASKS INCLUDED IN ACTIVITY
Code	Description	
64	Prepare final special studies	Determine the need for special studies Request and receive specialized assistance Problem analysis, potential solution development and solution approval
65	Develop final right-of-way plans	Transmit right-of-way plans to Right-of-Way Division
66	Revise special provisions	Update all special provisions
67	Revise miscellaneous features	Update all miscellaneous design features Supply information and cooperation needed to revise right-of-way limits, utility plans, final right-of-way and fencing plans.
68	Develop final cost estimate	Recieve cost estimate data from district Prepare final cost estimate Transmit cost estimate to Project Control Section
71	Tracing and final plans preparation	Tracing and inking of final plans Checking for tracing accuracy
72	Conduct final check	Review and check of final plans for adequacy and accuracy Transmit to Contract Plans Unit
81	Supervision	Project supervision by persons in senior supervisory positions or higher which cannot be directly related to specific work activities. Supervision directly related to specific work activities will be charged to the activity.
91	Annual leave	
92	Sick leave	
93	All other types of leave	
99	Standby	Standby, waiting for project assignments, or waiting for other persons to complete work so that work may be continued.

Figure 12

SE - 8

MONTHLY OBJECTIVES

AND STATUS OF ROAD DESIGN

Project Number _____ Month Reported _____

Project Supervisor _____

MILESTONES AND WORK ACTIVITIES		SCHEDULED AND ACTUAL PROGRESS BY PERCENT OF ACTIVITY COMPLETED										
		Current Month		Current Mo +1		Current Mo +2		Current Mo +3				
Name	Code	Sched.	Act.	Sched.	Act.	Sched.	Act.	Sched.	Act.	Cur Mo + 4 Sched.	Cur Mo + 5 Sched.	Remarks

Monthly Objectives and Status of Road Design

The Monthly Objectives and Status of Road Design Report, form SE-8, serves two purposes. It is a computer output report that summarizes scheduled monthly design objectives for the comming six months, and it is used by Road Design supervisors to report accomplishments. Figure 12 is an example of this report.

At the beginning of each quarter (January 1, April 1, July 1, and October 1) the designer receives the original and three carbon copies of the Monthly Objectives and Status of Road Design Report (the carbon paper will be left between the sheets). The scheduled percent completion, for each activity and milestone, will be preprinted in the scheduled columns. At the close of the first month of the reporting period the project supervisor records the actual percent completion for each activity. He tears off the first sheets, of the four sheets package, and submits it to the senior supervisor (Area Engineer) for review. The first carbon is removed and disposed.

At the close of the second month the process is repeated except actual progress is shown in the second column. In this way the project supervisor has his last months report in front of him (as shown in the first column on the carbon copy on which he is working) while preparing the report for the current month, and he is not delayed by computer turn-around time.

At the end of the third month the project supervisor completes and transmits the third sheet in the same manner. The fourth sheet is retained as his record of project progress.

The Monthly Objectives and Status of Road Design Report will be completed and transmitted to the senior supervisor by the third working day of the month following the report month.

The senior supervisor will complete his review and transmit the reports to Data Processing by the fifth working day of the month. This procedure alerts project and senior supervisors to scheduling problems without awaiting computer output reports. If problems are identified, appropriate remarks should be placed in the space provided and the Location and Road Design Supervisor should be informed.

Figure 13

SE-9

MONTHLY STATUS REPORT

Report Month _____

PROJECT IDENTIFICATION Number Length Type Location Senior Supervisor	Contract Letting Date	MILESTONES DESCRIPTIONS	COMPLETED MILESTONES		ACTIVE MILESTONES			Future Milestone Date Scheduled
			Date Scheduled	Date Completed	Date Scheduled	Percent Complete	Working Days Left	

If the timely completion of a milestone event is in question, or if serious problems have been encountered, the Location and Road Design Supervisor will inform the Chief Bureau of Road Design to ensure that he is informed and approves of proposed corrective actions.

Completion Deadlines for Field Surveys

Completion Deadlines for Field Surveys, form SE-3, is also a combination scheduling and progress evaluation report. The scheduling portion of the report has been explained and an example of the report format is shown in Figure 4. The report is issued by Data Processing once each year, and revised if rescheduling causes the field deadlines to be revised.

The progress evaluation portion of the report -- the last two columns -- are completed each month by the Division to whom the work has been assigned. Monthly report completion steps are as follows:

1. Monthly reports will be prepared whenever a Division has an active or uncompleted field survey assigned to them.

2. A Xerox copy of the Completion Deadlines for Field Surveys Report is made.

3. The Division enters the percent complete each survey is at the close of the report month.

4. The Division forwards the monthly report to Data Processing by the third regular working day of the month.

Monthly Status Report

The Monthly Status Report is a computer output report prepared by Data Processing. Its purpose is to report the status of each active road design project by milestone event. An example of the report is shown in Figure 13.

Figure 14

SE - 10

MISSED MILESTONE DATES

Report Month _____

Project Number/Length and Type	-----SUPERVISION---- Senior/Project	MISSED MILESTONE				Remarks
		Completion Event	Scheduled Complete Date	Days Behind Schedule	Percent Man-Hours Used	

The progress portion of the report is divided into three areas -- completed milestone, active milestones, and future milestones.

The completed milestones portion of the report gives the dates milestones were scheduled for completion and the dates actually completed.

The next three columns report progress on milestones upon which work is currently being performed and the number of working days left before the milestone is scheduled for completion. If the scheduled milestone date has passed, the the number of working days that have elapsed since the scheduled completion date will be shown.

The last column shows the scheduled completion dates for milestones upon which work has not yet commenced.

This report is distributed to the following personnel by Data Processing:

Location and Road Design Supervisor
Chief Bureau of Road Design
Assistant State Highway Engineer -- Preconstruction

Missed Milestones Report

The Missed Milestones Report, SE-10 is an exception report. The only projects to appear on this report are those which did not complete a milestone event by the scheduled completion time. The report will show the event, the scheduled completion date, the number of working days the event is behind schedule, and the percent of planned man-hours that have been used. The latter -- percent man-hours used -- describes the effort that has been used in attempting to complete the event.

Two copies of the report, an example of which is shown in Figure 14, will be prepared by Data Processing. Copies will be transmitted to the Chief Bureau of Road Design and the Location and Road Design Supervisor. The Location and Road Design Supervisor will discuss the project status with the responsible senior supervisor. Appropriate comments will be placed in the remarks section of the report and discussed with the Chief Bureau of Road Design who will evaluate the need for advising higher authorities and rescheduling.

Figure 15

SE-11

MANPOWER CONTROL REPORT

Senior Supervisor _____ Report Month _____

Project Number	ESTIMATED TOTAL MAN-MONTHS		MAN-MONTHS TO DATE			SCHEDULED MAN-MONTHS						
	Original	Revised	Estimate	Actual	Percent of Estimate	Next Month	Next Month + 1	Next Month + 2	Next Month + 3	Next Month + 4	Next Month + 5	Balance to Complete
TOTAL												
RECAP BY PERSONNEL CLASS. Technician I Technician II Technician III Senior Technician Project Supervisor Senior Supervisors												
TOTAL												

This report is a red flag for Road Design. It advises them that a check point was not reached as scheduled. Since the report is a exception report only scheduling deviations are shown. Each project listed deserves attention, analysis and corrective action.

Manpower Control Report

The Manpower Control Report, form SE-11, describes the total estimated man-months required to do a project, the man-months used through the month covered by the report, and the scheduled manpower requirements for the coming six month period. The reports will be organized by senior supervisor, as shown in Figure 15. And a summary report will be prepared, in the same format, that will cover all active Road Design projects. Each format of this report will recap manpower requirements by personnel classification. Senior supervisors will compare estimated manpower requirements with expected manpower availability and individual project assignments. Appropriate adjustments will be made. Needed manpower adjustments beyond the authority of the Senior Supervisor will be brought to the attention of the Location and Road Design Supervisor who will take or initiate required actions.

Data processing will prepare two copies of each report. One copy will be directed to the senior supervisor shown on the report. The summary road design report and one copy of individual reports will be transmitted to the Location and Road Design Supervisor. One copy of the summary report will be transmitted to the Chief Bureau of Road Design.

Budget Analysis Report

Figure 16 is an example of the Budget Analysis Report, form SE-12. This report is prepared monthly and is a summary labor cost report. Two copies are prepared. One copy is sent to the Chief Bureau of Road Design. The second copy goes to the Location and Road Design Supervisor.

The purposes of the report are (1) to compare total funds available with total funds spent, and (2) to project fund requirements for the balance of the fiscal year. A revised fiscal year cost estimate is made by adding costs to date and the estimated balance to complete during the current year.

Figure 16

BUDGET ANALYSIS REPORT

Report Month _____

Percent of Working Time Elapsed _____

Personnel Classification	FISCAL YEAR BUDGET		TOTAL TO DATE		ESTIMATED BALANCE TO COMPLETE		REVISED FISCAL YEAR ESTIMATE	
	Man-Months	Dollars	Man-Months	% of Budget	Man-Months	Full-time Equivalent	Man-Months	Dollars
Technician I								
Technician II								
Technician III								
Senior Technician								
Project Supervisor								
TOTAL								

Costs shown on this report are developed from standard labor costs by personnel classification. Costs cannot, therefore, be directly related to actual payroll costs. However, if properly updated these costs will be within three percent of actual payroll expenditures.

MANPOWER PLANNING VALUES

Manpower planning values have been established. Figure 17 shows the values used at the start of the program.

> NOTE: The number of man-hours planned for a project is determined by adding the percent adjustments shown in Figure 17 and multiplying the sum times the man-hours per unit for each activity.
>
> For example the number of man-hours planned for the activity Prepare Planning Report on an Interstate project is 52 hours (man-hours per unit) times 150% (Interstate Adjustment) which equals 78 hours. A primary project is 52 hours times 100% or 52 Hours.

Adjustment of planning values is the responsibility of the Location and Road Design Supervisor, with the approval of the Chief, Bureau of Road Design. There are three values to be adjusted. They are:

1. Planning values by work activity and project characteristics

2. Planning values by work activity and personnel classification.

3. Standard labor costs by personnel classification.

The first two values are adjusted with the assistance of a data processing output report -- Standards Adjustment Report, form SE-91.

Standard labor costs are adjusted by manual computations.

Figure 17

PLANNING VALUES

WORK ACTIVITY DEFINITION / ITEM	Prepare Planning Report	Prepare Master Linens and Computer Inputs of Survey Data	Special Feature Layout Design	Pavement Structural Section Design	Develop Major Control Points	Develop Right-of-Way Ownership Data	Secure Airport Clearance	Develop Hydraulics Recommendations	Develop Preliminary Alignment and Grade	Bridge or Structure Layout Design	Develop Earthwork Quantities	Develop Final Typical Sections	Develop Major Special Provisions
UNIT OF MEASURE	Project	Mile	Feature	Project	Mile	Mile	Project	Project	Mile	Project	Project	Project	Mile
MAN-HOURS PER UNIT	52.0	16.0	81.0	4.0	3.0	0.5	4.0	4.0	9.0	4.0	17.5	16.0	4.0
ADJUSTMENTS:													
Interstate	150%	100%	--	100%	100%	100%	100%	100%	100%	100%	100%	150%	150%
Primary	100%	100%	--	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Secondary	100%	100%	--	100%	100%	100%	100%	100%	125%	100%	100%	100%	100%
Urbon	100%	200%	--	100%	100%	100%	100%	100%	200%	100%	100%	100%	100%
Irrigated	--	--	--	--	--	--	--	--	30%	--	--	--	--
Mountoinous	10%	25%	--	--	50%	--	--	--	50%	--	100%	--	50%
Unit of Measure for Speciol Features	None	None	Feature	None	None	None	None	None	None	None	None	Feature	Mile
Interchonges	--	--	100%	--	--	--	--	--	--	--	--	100%	--
Weigh Stations	--	--	100%	--	--	--	--	--	--	--	--	50%	--
Rest Areos	--	--	150%	--	--	--	--	--	--	--	--	50%	--
Major Intersections	--	--	50%	--	--	--	--	--	--	--	--	25%	--
Frontoge Roods	--	--	--	--	--	--	--	--	--	--	--	--	100%
Detour Roads	--	--	--	--	--	--	--	--	--	--	--	--	50%
DISTRIBUTION BY PERSONNEL CLASSIFICATION													
Technicion I	--	--	--	--	--	--	--	--	--	--	--	--	--
Technician II	--	50%	--	100%	16%	--	--	--	22%	--	--	--	--
Technicion III	--	50%	--	--	--	--	--	--	--	100%	--	75%	--
Senior Technician	4%	--	70%	--	67%	100%	--	100%	78%	--	100%	25%	--
Project Supervision	96%	--	30%	--	16%	--	100%	--	--	--	--	--	100%

Figure 17

PLANNING VALUES

WORK ACTIVITY DEFINITION / ITEM	Prepare Preliminary Plans	Check Preliminary Plans	Conduct Preliminary Plan-In-Hand inspection	Prepare Preliminary Plan-In-Hand Report	Conduct Special Studies for Major Problems	Landscape and Beautification Design	Develop Special Provisions	Develop Cost Estimate	Plot and Template Remaining Cross Sections	Secure Borrow and Surfacing Site Options	Establish Final Geometric Ties	Approach and Entrance Design	Prepare Final Grading
UNIT OF MEASURE	Mile	Mile	Project	Project	Project	Project	Project	Mile	Mile	Project	Feature	Mile	Mile
MAN-HOURS PER UNIT	7.0	5.0	34.5	12.0	14.0	4.0	8.5	3.1	24.0	6.0	25.0	13.0	7.2
ADJUSTMENTS:													
Interstate	100%	100%	125%	100%	400%	100%	200%	200%	150%	100%	--	--	100%
Primary	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	--	100%	100%
Secondary	100%	100%	75%	100%	100%	--	100%	67%	100%	100%	--	200%	100%
Urban	120%	100%	100%	100%	200%	100%	100%	100%	150%	100%	--	100%	100%
Irrigated	--	--	20%	--	100%	--	50%	33%	20%	--	--	--	--
Mountainous	--	--	25%	--	50%	--	50%	33%	50%	--	--	--	--
Unit of Measure for Special Features	None	None	None	None	Feature	None	Feature	Mile	Feature	None	Feature	Mile	Mile
Interchanges	--	--	--	--	--	--	--	--	150%	--	100%	--	--
Weigh Stations	--	--	--	--	100%	--	50%	--	100%	--	100%	--	--
Rest Areas	--	--	--	--	100%	--	50%	--	100%	--	150%	--	--
Major Intersections	--	--	--	--	100%	--	50%	--	100%	--	50%	--	--
Frontage Roads	--	--	--	--	--	--	--	50%	--	--	--	100%	50%
Detour Roads	--	--	--	--	--	--	--	50%	--	--	--	--	50%
DISTRIBUTION BY PERSONNEL CLASSIFICATION													
Technician I	--	--	--	--	--	--	--	--	--	--	--	--	14%
Technician II	27%	--	--	--	--	--	--	--	67%	--	--	--	56%
Technician III	--	--	--	--	--	--	--	52%	33%	100%	--	38%	--
Senior Technician	2%	20%	--	--	--	--	--	--	--	--	100%	62%	30%
Project Supervision	71%	80%	100%	100%	100%	100%	100%	48%	--	--	--	--	--

Figure 17

PLANNING VALUES

WORK ACTIVITY DEFINITION / ITEM	Update Right-of-Way Linens	Design Contour Grading	Signing Layout and Design	Seed, Mulch and Topsoil Design	Retaining Wall Design	Adjustments to Grade	Curb, Gutter and Sidewalk Design	Concrete Slope Protection Design	Guardrail and Embankment Protector Design	Linear and Level Data Sheet Preparation	Pipe and Ditch Block Design	Feature Removal and Reset Design	Construction Limit and Right-of-Way Design
UNIT OF MEASURE	Mile	Feature	Project	Project	Project	Mile	Mile	Project	Mile	Project	Mile	Mile	Mile
MAN-HOURS PER UNIT	0.5	80.0	1.0	12.5	10.0	6.0	36.0	4.5	11.0	8.0	10.0	6.0	3.0
ADJUSTMENTS:													
Interstate	100%	--	100%	200%	100%	--	--	200%	150%	150%	125%	--	100%
Primary	100%	--	100%	100%	100%	--	--	100%	100%	100%	100%	--	100%
Secondary	100%	--	100%	100%	100%	--	--	100%	75%	100%	100%	--	100%
Urban	100%	--	100%	100%	100%	100%	100%	--	10%	100%	100%	100%	100%
Irrigated	--	--	--	--	--	--	--	--	--	--	50%	--	--
Mountainous	--	--	--	--	--	--	--	--	50%	--	100%	--	66%
Unit of Measure for Speciol Feotures	None	Feature	None	Feature	None	Mile	Mile	None	Mile	None	None	Mile	Mile
Interchanges	--	100%	--	80%	--	--	--	--	--	--	--	--	--
Weigh Stations	--	--	--	80%	--	--	--	--	--	--	--	--	--
Rest Areas	--	50%	--	80%	--	--	--	--	--	--	--	--	--
Major Intersections	--	50%	--	40%	--	--	--	--	--	--	--	--	--
Frontage Roods	--	--	--	--	--	100%	100%	--	50%	--	100%	100%	100%
Detour Roads	--	--	--	--	--	100%	--	--	10%	--	--	--	--
DISTRIBUTION BY PERSONNEL CLASSIFICATION													
Technicion I	--	--	--	--	--	--	--	--	--	--	--	--	--
Technicion II	--	--	--	48%	30%	100%	--	--	--	--	20%	100%	100%
Technicion III	--	66%	--	--	--	--	--	56%	86%	80%	--	--	--
Senior Technician	100%	34%	100%	52%	70%	--	100%	44%	14%	20%	50%	--	--
Project Supervision	--	--	--	--	--	--	--	--	--	--	30	--	--

Figure 17

PLANNING VALUES

WORK ACTIVITY DEFINITION / ITEM	Monuments and Markers Design	Plot Topography	Conduct Design Public Hearing and Prepare Report	Preparation of Contract Plans Sheets	Conduct Final Plan-In-Hand Inspection	Prepare Final Plan-In-Hand Report	Prepare Final Special Studies	Develop Final Right-of-Way Plans	Revise Special Provisions	Revise Miscellaneous Features	Develop Final Cost Estimate	Tracing and Final Plans Preparation	Conduct Final Check
UNIT OF MEASURE	Mile	Mile	Project	Mile	Project	Project	Project	Project	Project	Mile	Project	Project	Project
MANHOURS PER UNIT	1.6	4.0	57.0	15.1	38.5	13.0	14.0	1.0	3.0	16.0	4.0	48.0	80.0
ADJUSTMENTS:													
Interstate	100%	100%	100%	150%	125%	100%	100%	100%	100%	100%	100%	200%	150%
Primary	100%	100%	100%	100%	90%	100%	100%	100%	100%	100%	100%	100%	100%
Secondary	80%	100%	100%	100%	75%	100%	100%	100%	100%	100%	100%	100%	100%
Urbon	--	500%	100%	100%	90%	100%	100%	100%	100%	100%	200%	150%	100%
Irrigoted	--	--	--	10%	20%	--	--	--	--	--	--	--	--
Mountoinous	--	--	--	--	25%	--	--	--	--	--	--	--	--
Unit of Measure for Special Feotures	None	None	None	None	None	None	None	None	None	None	None	Feature	None
Interchanges	--	--	--	--	--	--	--	--	--	--	--	50%	
Weigh Stotions	--	--	--	--	--	--	--	--	--	--	--	50%	--
Rest Areos	--	--	--	--	--	--	--	--	--	--	--	50%	--
Major Intersections	--	--	--	--	--	--	--	--	--	--	--	--	--
Frontoge Roads	--	--	--	--	--	--	--	--	--	--	--	--	--
Detour Roods	--	--	--	--	--	--	--	--	--	--	--	--	--
DISTRIBUTION BY PERSONNEL CLASSIFICATION													
Technicion I	--	50%	--	--	--	--	--	--	--	--	--	--	--
Technicion II	--	50%	25%	60%	--	--	--	--	--	30%	--	50%	--
Technician III	100%	--	--	30%	--	--	--	--	--	30%	--	50%	--
Senior Technicion	--	--	--	--	--	--	--	100%	--	30%	--	--	50%
Project Supervision	--	--	75%	10%	100%	100%	100%	--	100%	10%	100%	--	50%

Man-hours Planning Values

Figure 18 is an example of the Man-hours Standards Adjustment Report that will be developed once a year by data processing. However, the Location and Road Design Supervisor may request that this report be prepared at anytime. However, Data Processing will update the data for each activity only after the milestone covering that activity has been completed. The procedure will minimize the revisions required when designers find they must recycle portions of the work. It will, therefore, be of little value for this report to be prepared more frequently than quarterly.

Revision of manpower planning values is accomplished by preparing the data shown in Figure 17 and transmitting them to Data Processing together with a revision request showing effective date.

Standard Labor Costs

Standard labor costs provide Data Processing with a means of converting labor hours to dollars without keeping track of the rates of pay of each employee. Figure 19 is an example of the format which may be used in communicating the standard labor costs to data processing.

Standard labor costs may be revised at anytime, but they should be revised (1) whenever the rates of pay of most individuals have been adjusted, and (2) once each year. No attempt should be made to reflect changes in individual rates, since these changes will tend to offset each other.

Computation of standard labor costs is accomplished by calculating a weighted average hourly salary rate for each personnel classification.

This calculation is:

1. Sum the rates of pay for all Technicians 1.
2. Divide the sum by the number Technicians 1.

Figure 18

SE - 91

EXAMPLE

MAN-HOURS STANDARDS ADJUSTMENT REPORT

Activity Planning Report Report Period 1971

Unit Of Measure Project

	CURRENT	ACTUAL			
		Range			
	STANDARD	From	To	Weighted Average	No. of Projects
Man Hours Per Unit	52	20	240	63	85
ADJUSTMENTS:					
Interstate	150%	55	240	73	21
Primary	100%	20	175	60	29
Secondary	100%	40	69	55	18
Urban	100%	50	105	80	37
Irrigated	--	40	69	55	40
Mountainous	10%	75	200	100	19
Interchanges	--	--	--	--	--
Weigh Stations	--	--	--	--	--
Rest Areas	--	--	--	--	--
Major Intersections	--	--	--	--	--
Frontage Road	--	--	--	--	--
Detour Road	--	--	--	--	--
MAN HOURS DISTRIBUTION BY PERSONNEL CLASSIFICATION:					
Technician I	--	--	20%	--	
Technician II	--	--	30	2%	
Technician III	--	--	35%	5%	
Senior Technician	4%	5%	80%	10%	
Project Supervisor	96%	25%	100%	83%	

Figure 19

SE-93

STANDARD LABOR COSTS

Date Prepared August 10, 1971

Date Effective Example

Code	Personnel Classification Title	Hourly Rate
11	Technician I	$3.17
12	Technician II	3.23
13	Technician III	3.91
14	Senior Technician	4.35
15	Project Manager	5.73
16	Senior Manager	6.85
21	Engineer	4.60
22	Project Engineer	5.87
23	Senior Engineer	7.25

SUMMARY OF

INPUT REPORTING REQUIREMENTS

Milestone Dates	SE-1	Location and Road Design Supervisor
Completion Deadlines - Field Surveys	SE-3	Division
Project Characteristics	SE-4	Project Supervisors
Weekly Time Sheet	SE-7	All Covered Employees
Monthly Objectives and Status of Road Design	SE-8	Project Supervisors
Planning Values	--	Location and Road Design Supervisor
Standard Labor Costs	SE-93	Location and Road Design Supervisor

PERSONNEL CLASSIFICATION
AND SALARY

CONTENTS

EXISTING PERSONNEL CLASSIFICATION AND SALARY PLAN

+ Existing personnel classification and wage schedule
+ Existing salary grade and incremental step plan

TURNOVER ANALYSIS

+ Results of turnover analysis

SALARY AND TERMS OF EMPLOYMENT SURVEY

+ Example out-of-state survey forms
+ Salary survey training materials
+ Example in-state survey forms
+ Salary survey results
+ Terms of employment survey results

IMPROVED PERSONNEL CLASSIFICATION AND SALARY PLANS

+ Summary classification definitions
+ Classification statements
+ Activities by level of difficulty
+ Salary Plan
+ Rate of progression plan
+ Implementation plan
+ Cost estimates

EXISTING PERSONNEL

CLASSIFICATION AND SALARY PLANS

STATE HIGHWAY COMMISSION
HELENA, MONTANA

PERSONNEL CLASSIFICATION AND WAGE SCHEDULE
Effective July 1, 1969
For Headquarters and Field Forces

OCC. CODE NO.	TITLE	SALARY GRADE	RANGE FROM	RANGE TO
186	State Highway Engineer	G-35	$1,593.00***	
077	Asst. State Highway Engineer-Administration	G-34	1,197.00	1,431.00
207	Asst. State Highway Engineer-Engineering			
212	Asst. State Highway Engineer-Operations			
258	Chief Counsel			
264	Chief R/W Attorney			
262	R/W Attorney IV	G-33	1,141.00	1,365.00
152	Bridge Engineer	G-32	1,092.00	1,309.00
007	Chief Accountant			
176	Chief R/W Agent			
154	Construction Engineer			
166	Maintenance Engineer			
167	Materials Engineer			
170	Preconstruction Engineer			
169	Project Control Engineer			
158	District Engineer	G-30	998.00	1,197.00
261	R/W Attorney III			
078	Commission Secretary	G-29	952.00	1,141.00
063	Chief Pilot			
163	Hydraulics Engineer	G-28	908.00	1,092.00
168	Office Engineer			
177	R/W Utilities Engineer			
180	Secondary Roads Engineer			
187	Specifications Engineer			
189	Traffic Engineer			
164	Urban Engineer			
181	Sr. Asst. Bridge Engineer			
183	Sr. Asst Chief R/W Agent			
149	Sr. Asst. Construction Engineer			
182	Sr. Asst. Maintenance Engineer			
188	Sr. Asst. Materials Engineer			
232	Project Control Analyst			
155	Data Processing Director			
043	Personnel Director			

OCC. CODE NO.		TITLE	SALARY GRADE	RANGE FROM	RANGE TO
086		G.V.W. Director	G-28	908.00	1,092.00
041		Planning Survey Director			
238		Field Design Engineer			
030		Information Director			
008		Asst. Chief Accountant			
159		Division Engineer			
301		Division Maintenance Supervisor			
174		Research Engineer			
233		Regional Engineer			
134		Asst. Bridge Engineer	G-26	830.00	998.00
150		Asst. Construction Engineer			
137		Asst. Maintenance Engineer			
138		Asst. Materials Engineer			
148		Asst. Preconstruction Engineer			
239		Consultant Design Engineer			
175		Asst. Chief R/W Agent			
275		Chief Appraiser			
276		Chief Negotiator			
252		Land Agent			
260		R/W Attorney II			
046		Budget Analyst			
104		Chief Geologist			
234		Area Engineer	G-24	763.00	908.00
153		Communcations Engineer			
111		Special Assignments Engineer III			
124		Surfacing Design Supervisor			
132		Asst. Consultant Design Engineer			
133		Asst. Hydraulics Engineer			
139		Asst. Office Engineer			
038		Asst. Planning Survey Director			
136		Asst. R/W Utilities Engineer			
145		Asst. Traffic Engineer			
087		Asst. G.V.W. Director			
302		Asst. Maintenance Supervisor			
151		R/W Plans and Programs Engineer			
208		District R/W Supervisor			
209		Data Program Supervisor			
011		Chief Auditor			
172	*3	Resident Engineer II	G-23	730.00	869.00
162		Division Office Engineer III			
110		Special Assignments Engineer II			
118		Designer III			
123		Landscape Designer III			
103		Geologist III			
231		Systems Programmer			
140		Asst. Research Engineer			
271		Reviewing Appraiser			

OCC. CODE NO.		TITLE	SALARY GRADE	RANGE FROM	RANGE TO
273		Reviewing Negotiator	G-23	730.00	869.00
250		Asst. Land Agent			
257		Abstractor II			
058		Purchasing Agent			
214		Core Drill Supervisor			
184		Soils Engineer (Helena Lab Only)			
090		Processing & Photography Supervisor			
022		Safety Director			
157		Research Supervisor II			
107		Chemist III			
229		Testing Supervisor			
230		Quality Control Supervisor			
047		Utilities Auditor			
199		Data Programmer IV			
236		Project Control Coordinator II			
205		Contract Plans Manager			
066		Personnel Asst. III			
171	*2	Resident Engineer I	G-21	669.00	797.00
161		Division Office Engineer II			
109		Special Assignments Engineer I			
117		Designer II			
122		Landscape Designer II			
102		Geologist II			
215		Division Materials Supervisor II (Field Only)			
039		Special Assignments - Administration			
106		Chemist II			
210		Operations Supervisor			
198		Data Programmer III			
004		Accountant IV			
255	*3	R/W Agent III			
249		Utility Agent IV			
256		Abstractor I			
250		Asst. Land Agent			
472		Plans Coordinator IV			
156		Research Supervisor I			
203		Engineering Technician III			
460		Traffic Engineering Technician III			
206		Planning Technician III			
033		Helena Shop Superintendent			
135		Asst. Communications Engineer			
024		Civil Defense Coordinator			
023		Labor Coordinator-Economist			
029		Information Officer			
259		R/W Attorney I			
211		Estimates Supervisor III			
065		Personnel Assistant II			
310		Maintenance Equipment Reviewer			
061		Photographer III			
088		Statewide GVW Scale Supervisor			
235		Project Control Coordinator I			
112		Photogrammetric Chief			
010		Auditor III			

OCC. CODE NO.		TITLE	SALARY GRADE	RANGE FROM	RANGE TO
202		Estimates Supervisor II	G-20	641.00	763.00
040		Office Manager			
195	*1	Instrumentman	G-19	612.00	730.00
193	*1	Bridge Inspector			
160		Division Office Engineer I			
216		Division Materials Supervisor I (Field Only)			
204		Materials Supervisor (Helena Lab Only)			
101		Geologist I			
144		Research Assistant II			
105		Chemist I			
247		Division Utility Agent			
116		Designer I			
127		Landscape Designer I			
121		Detailer II			
165		Engineer-in-Training			
242		Equal Employment Opportunity Officer			
237		Project Control Coordinator Trainee			
254	*2	R/W Agent II			
270		Property Description Reviewer			
274		Asst. Reviewing Negotiator			
471		Plans Coordinator III			
248		Utility Agent II			
197		Data Programmer II			
070		Data Processor IV			
003		Accountant III			
009		Auditor II			
126		Project Director II			
173		Radio Engineer			
060		Photographer II			
085		G.V.W. Scale Supervisor			
031		Field Labor Inspector			
021		Asst. Safety Director			
213		Asst. Core Drill Supervisor			
064		Personnel Assistant I			
468		Planning Technician II			
219		Traffic Engineering Technician II			
446		Engineering Technician II			
442		Cartographer III			
093		Statistical Clerk III			
306		Maintenance Foreman			
309		Shop Foreman			
337		Sign Shop Foreman (Helena)			
336		Carpenter Foreman Special Assignments			
119		Stereo Plotter Operator II			
120		Detailer I	G-17	557.00	669.00
128		Agronomist			
143		Research Assistant I			
224		Laboratory Technician IV			
099		Core Sampler IV			

OCC. CODE NO.		TITLE	SALARY GRADE	RANGE FROM	RANGE TO
269		Reviewer I	G-17	557.00	669.00
253	*1	R/W Agent I			
266		R/W Office Coordinator II			
246		Utility Agent II			
470		Plans Coordinator II			
196		Data Programmer I			
069		Data Processor III			
002		Accountant II			
006		Auditor I			
201		Estimates Supervisor I			
220		Contract Provisions Technician I			
125		Project Director I			
059		Photographer I			
226		Radio Technician II			
089		Office Service Supervisor			
055		Permit Agent			
094		Statistical Clerk II			
441		Cartographer II			
467		Planning Technician I			
218		Traffic Engineering Technician I			
445		Engineering Technician I			
026		Information Writer II			
013		Senior Clerk (Field Offices Only)			
217		Office Supply Supervisor			
200		Rodman	G-15	512.00	612.00
131		Draftsman III			
194		Materials Inspector			
223		Laboratory Technician III			
098		Core Sampler III			
265		R/W Office Coordinator I			
251		Asst. R/W Agent			
245		Utility Agent I			
469		Plans Coordinator I			
076		Secretary to State Highway Engineer			
019		Clerk V			
068		Data Processor II			
001		Accountant I			
091		Lithographer			
225		Radio Technician I			
054		Key Punch Supervisor			
450		Traffic Recorder II			
440		Cartographer I			
095		Statistical Clerk I			
114		Stereo Plotter Operator I			
192		Engineering Aide II	G-13	468.00	557.00
130		Draftsman II			
222		Laboratory Technician II			
097		Core Sampler II			
074		Secretary II			

OCC. CODE NO.	TITLE	SALARY GRADE	RANGE FROM	RANGE TO
017	Clerk IV	G-13	468.00	557.00
067	Data Processor I			
051	Processing Machine Operator II			
056	G.V.W. Scaleman			
057	G.V.W. Patrolman			
025	Information Writer I			
071	Programmer Trainee			
073	Secretary I	G-12	445.00	534.00
016	Clerk III			
053	Key Punch Operator III			
050	Processing Machine Operator I			
449	Traffic Recorder I			
227	Project Control Technician			
191	Engineering Aide I	G-11	428.00	
129	Draftsman I			
221	Laboratory Technician I			
096	Core Sampler I			
084	Stenographer II	G-10	413.00	490.00
015	Clerk II			
049	Key Punch Operator II			
466	Planning Aide II			
083	Stenographer I	G-8	379.00	445.00
014	Clerk I			
048	Key Punch Operator I			
465	Planning Aide I			
020	Clerk-Typist II	G-6	345.00	413.00
012	Clerk-Typist I	G-4	313.00	379.00

*Additional compensation for Professional Engineering Employees and Right-of-Way Agents devoting extra time, as required, to field supervision of contractors' construction operations or field operations in the Right-of-Way acquisition respectively:

1. $35.00 per month
2. $40.00 per month
3. $45.00 per month

***Set by Legislative Law

STATE HIGHWAY COMMISSION

Helena, Montana

SALARY GRADE AND INCREMENTAL STEP PLAN

July 1, 1969

Salary Grade	I	II	III	IV	V
G-37	1365	1431	1498	1566	1632
G-36	1309	1365	1431	1498	1566
G-35	1254	1309	1365	1431	1498
G-34	1197	1254	1309	1365	1431
G-33	1141	1197	1254	1309	1365
G-32	1092	1141	1197	1254	1309
G-31	1042	1092	1141	1197	1254
G-30	998	1042	1092	1141	1197
G-29	952	998	1042	1092	1141
G-28	908	952	998	1042	1092
G-27	869	908	952	998	1042
G-26	830	869	908	952	998
G-25	797	830	869	908	952
G-24	763	797	830	869	908
G-23	730	763	797	830	869
G-22	696	730	763	797	830
G-21	669	696	730	763	797
G-20	641	669	696	730	763
G-19	612	641	669	696	730
G-18	585	612	641	669	696
G-17	557	585	612	641	669
G-16	534	557	585	612	641
G-15	512	534	557	585	612
G-14	490	512	534	557	585
G-13	468	490	512	534	557 562* 568**
G-12	445	468	490	512	534
G-11	428	445	468	490	512
G-10	413	428	445	468	490
G-9	396	413	428	445	468
G-8	379	396	413	428	445
G-7	362	379	396	413	428
G-6	345	362	379	396	413
G-5	329	345	362	379	396
G-4	313	329	345	362	379

* GVW Scalemen

** Maintenanceman 1

TURNOVER ANALYSIS

ANNUAL TURNOVER

GRADUATE ENGINEERS

YEAR	TOTAL TURNOVER (Percent)	VOLUNTARY TURNOVER (Percent) [1/]
1967	10%	4%
1968	14	8
1969	15	13
1970	20	15

1/ Excludes involuntary turnover including retirements, deaths, and military service.

TERMINATIONS OF GRADUATE

ENGINEERS BY REASON

(1967 - 1970)

REASON FOR TERMINATION	NUMBER OF PERSONNEL	PERCENT OF TOTAL ENGINEERS
Other employment	29	58%
Personal	4	8
Continue schooling	2	4
Military service	8	16
Retirement	9	14
TOTAL	50	

ANNUAL TURNOVER BY

CLASSIFICATION GRADE

TECHNICIANS

(1970)

CLASSIFICATION GRADE	NUMBER OF TERMINATIONS	TOTAL TURNOVER (Percent)
G-13	71	29%
G-15	17	7
G-17	1	2
G-19	9	5
G-21	1	2
G-23	0	0
	99	12%

SALARY AND TERMS OF

EMPLOYMENT SURVEY

Form 10 Identification Number_____

_____

SALARY SURVEY QUESTIONNAIRE

DRAFTSMEN -- DESIGNERS

State highway departments design their own highways and bridges or engage consultant design firms for this purpose. In either case, persons skilled in drafting and design work must be employed for the original work or for review and approval phases.

Positions offered by consultants, by industries and by other government agencies which involve the development of detailed blueprints or other plans for civil, mechanical or electrical projects are equivalent to those offered by the Department. If doubt as to the comparability of a given position or of several positions exists, include the data requested and notes descriptive of the positions.

Draftsmen One -- Persons with training in mechanical drawing and mathematics and little or no experience who perform simple tracing, lettering and inking in the development of engineering or architectural drawings. The most difficult assignments involve conversions of small sketches to scale drawings.

Numbers of Persons	Salaries Paid	Per
_____	$_____	_____
_____	_____	
_____	_____	
_____	_____	

Notes or comments:_____

_____

_____

_____

_____

Does the annual turnover rate for year-round personnel in this group exceed 20 percent?_____

Draftsmen Three -- Skilled draftsmen who can develop segments of state highway maps, detailed right-of-way plats or such sections of a set of contract drawings as plan and profile sheets, typical cross-section sheets, quantities sheets or bridge deck drawings. Design decisions are made by superiors. Mathematical calculations of quantities or for the determination of scale values are made by Draftsmen Three. Persons in this classification are fully capable draftsmen.

Numbers of Persons	Salaries Paid	Per
_____	$_____	_____
_____	_____	
_____	_____	
_____	_____	

Notes: _____

_____

_____

_____

_____

Does the annual turnover rate of year-round personnel in this group exceed 15 percent? _____

Draftsman Four -- Designer One -- (The Same Classification) -- Persons who perform advanced drafting and/or repetitive design tasks within the framework of specific standards, policies, procedures and design formulae. Any unusual design work is accomplished by higher level specialist personnel and incorporated into the final plans by persons in this category. Final accountability for the accuracy of detail work and completeness of the plan data can be delegated to this level. Personnel in this classification may be experienced and well qualified technicians or inexperienced graduate engineers.

Numbers of Persons	Salaries Paid	Per
_____	$_____	_____
_____	_____	
_____	_____	
_____	_____	

Draftsmen Four -- Designers One (Con't)

Notes: _____

_____

_____

_____

_____

Designers Two and Up -- All higher level design work is performed by experienced engineers. See the Salary Survey Questionnaire for Engineers. No entry is necessary here.

SALARY SURVEY INSTRUCTIONS

INTERVIEW PROCEDURES

General Information

The Department is undertaking a salary survey to provide (1) a basis for developing prevailing rate salary plans for pre-construction personnel, and (2) to support budgetary information to be furnished to the Legislature.

We are conducting two types of surveys simultaneously -- a written survey and the survey you will conduct by oral interview.

The written survey is being accomplished by sending written questionnaires to employers located outside of Montana. These questionnaires will be returned directly to Roy Jorgensen Associates. You should be aware that this is being done in case questions arise. We do not wish to duplicate information. If employers indicate that they have previously responded to the survey, do not ask for the information again.

You will need to sell yourselves to the organizations you contact. They are under no obligation to cooperate, and you are asking for information that could be damaging to them if it gets in the wrong hands.

The following assurances should help:

1. All information is highly confidential. To keep it this way, employers are given identification numbers to prevent the inadvertent release of confidential information.

   Identification numbers are used so that employers can be classified by type and location. This is necessary if realistic salary plans are to be developed.

2. No employers will be identified in presenting or reporting the information developed. Only statistical summaries will be used that identify employers by classifications -- county government, city government, state agencies, small businesses, large businesses, etc.

3. A report will be developed by Roy Jorgensen Associates, Inc. Each participant will receive a complimentary copy of this report. The report will identify prevailing salary practices for key personnel classifications. It will also identify prevailing fringe benefit practices. It should be of value to the employer in checking his own salary and fringe benefit plans.

4. Their participation will ensure that the Highway Department has realistic salary plans. In this way they are contributing to better government in Montana.
5. If the employer desires, you will complete the information in his office and mail it to the Jorgensen office from his office.

Employer Listings and Identification

Each employer will be given an identification number. This number will appear on all documents containing any information about the employer. The employer's name will not appear on any of these documents.

You are being furnished a form which will cross reference employers and identification number. Only you and the survey staff are to have access to this information. It must be kept strictly confidential.

The identification number has a meaning which will help in the analyses of the information.

There are six digits in the number. Two digits followed by a dash, two more followed by a dash and the last two (00-00-00). The first two digits classify the type of employer. The codes for the first two digits are as follows:

01 Other State Agencies
02 Federal Agency
03 County Government
04 City Government
05 Heavy Contractor (dams and highway work. They will use and be heavy equipment oriented.)
06 Light Building Contractor (houses, etc.)
07 Utilities (MDU, telephone, etc.)
08 Consulting, C.P.A., or other services
09 Railroad
10 Other industrial (manufacturing)
11 Other Non-industrial

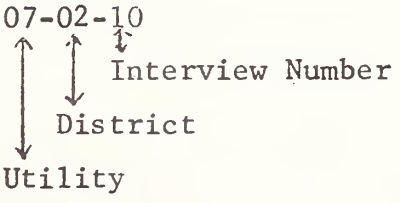
The next two digits describe the primary location (home office or business location in your area) of the employer. It will normally be the same as your district number, unless you are working outside your district.

01 District One
02 District Two

03 District Three
04 District Four
05 District Five
06 North Dakota
08 Wyoming
09 Idaho
10 Washington
11 Oregon

The last two digits will identify the individual interviews. The first interview will be 01, the second 02, etc.

Example: Assume you contact Montana Power Company in Butte and it is the tenth inverview you have done. The number will be:



Master File

You are being furnished a form titled "MASTER FILE, EMPLOYER IDENTIFICATION NUMBERS," form 31. Each firm assigned to you is listed on this form with an identification number.

Retain this form until you have completed all interviews. Then send it to Roy Jorgensen Associates, Inc. c/o Montana Highway Commission, Helena, Montana 59601.

The identification number is to be entered on all survey forms completed for each employer.

If additional firms are assigned to you, a new form will be sent with the assignment.

Types of Employment to be Covered

We will cover the types of employment in the Pre-Construction Division of the Highway Department.

The general personnel classifications to be covered by this survey are as follows:

General Office Management

Bookkeeping and Clerical

Clerks and Typists

Secretaries

Stenographers

Stock Clerks

Engineers

Technicians

Draftsmen

Detailers

Designers

If, in contacting employers, you are uncertain about reporting a classification, DO REPORT IT. We will determine if it applies.

CONDUCTING THE INTERVIEW

General

You are being furnished a letter of introduction identifying you as an authorized agent of the Department. Present your letter and introduce yourself. Briefly state the reasons for the interview, the advantages to the State and the potential advantages to the employer.

LET THE PERSON BEING CONTACTED TALK. If he has "a bone to pick" with government let him get it out of his system. Listen to him. If you hear him out, your chances of success will be greatly increased.

SELL, but if the employer is overly antagonistic, do not push too far. Remember you are representing the Department and community relations are part of your job. If he does not want to participate, thank him and leave. Replace him with another employer indicated on your list as a minor contact.

COMPLETING THE QUESTIONNAIRES

There are basically two types of forms. The first form, on blue paper, covers employers and their fringe benefit practices. The second form, on white paper covers rates of pay for individual personnel classifications.

Employer and Fringe Benefits Questionnaires (Form 1)

One of these forms will be completed for each employer contacted. It requests general information about the employer -- the size of his workforce, working conditions and fringe benefits plan.

The form is self explanatory. Most of the questions can be completed by putting a check mark in the appropriate space. If there are unusual situations that cannot be described on the form, simply write "OVER" in the appropriate space on the form and put your description on the back.

Salary Data (Form 21)

We are seeking to identify prevailing wage rates -- the wages and salaries paid by most firms and agencies to most employees by personnel classification. We are also seeking to identify geographical variations in the prevailing rates, if they exist.

It will be necessary for you to relate the employer's personnel classification and the Department's personnel classification. This can best be done in a step-by-step procedure..

First write down "Their Personnel Classification Title" in the space provided.

Then give a brief, but concise "Description of Duties" of personnel in this classification. THIS IS THE KEY TO THE INTERVIEW AND THE POINT WHERE MANY INTERVIEWERS FAIL. Take the time to write out a good description. The usefulness of the data will be determined primarily in this block. Do not rely on your memory. Write it down.

It will be necessary to relate the positions being reported to the Department's personnel classification plan. This may be done as the questionnaire is being completed, or later back at the office.

From the description of the duties, classify the job in the way you would classify it under the Department's personnel classification plan, if possible. Enter "Your Personnel Classification" in the space provided.

Example Number 1:

Their Personnel Classification Title: Clerk-Typist III

Description of Duties: A fully qualified clerk-typist who does routine repetitive typing at a rate of 50 words per minute or greater. Has no supervisory responsibility. Work is normally limited to routine repetitive correspondence or similar typing.

Your Personnel Classification: _____

Example Number 2:

Their Personnel Classification Title: Draftsman

Description of Duties: Routine draftsman duties. Makes tracings on linen, computes quantities and checks computations made by other draftsmen.

Your Personnel Classification: _____

Example Number 3:

Their Personnel Classification Title: Engineer II

Description of Duties: Responsible for the design of several simple and complex road and bridge projects. May perform the more complex design functions but supervises other designers and draftsmen in the routine design work.

Your Personnel Classification: _____

If you are unable to relate the job being reported to the Department's classification plan, leave "Your Personnel Classification" blank but complete the balance of the form.

Some jobs are going to be difficult to relate. Report them anyway. This will be checked in headquarters, but we want your thinking.

The next section relates to the rates of pay being given to individuals in this group. So that consistent actual rates of pay data can be generated, follow these guidelines:

1. Report the actual salaries paid, before deductions, rather than the salary ranges for the classification.

   Example: The salary range for Typist 1 runs from $265 to $310. Seven Typists 1 are employed. Four receive $300 per month and three receive $310. Report the actual rates of pay -- 4 at $300, 3 at $310 -- not the salary ranges -- $265 to $310.

2. Show the number of persons receiving each salary rate, but exclude individuals and rates that are exceptions to policy.

3. If the number of employees in a given classification exceeds 40, report the salaries paid for 40 persons selected at random or for the total force, whichever is easier. If a random selection is made, insure against any bias in the manner of selection.
4. In our evaluation we will convert professional and administrative employees to annual rates, clerical, technical and others will be converted to monthly rates. However, to make it easier for you to report, report them as they are paid -- hourly, daily, weekly, biweekly, monthly or annually, but identify the basis used.

The "Turnover Rate Per Year" is the total number of persons with this classification that left the workforce last year, divided by the total number of persons with this classification.

Example: Montana Power Company has ten Clerk-Typists 1. Last year six of these quit, were retired or were discharged. The turnover rate is 60% (6 ÷ 10).

Many employers will not know this information. Attempt to get a reasonable estimate if the actual rate is unknown. This rate gives us an idea of how effective the employer is in retaining his personnel. If he has a high turnover rate, we will be looking at his rates of pay very closely.

The final space, on the back of the form, is for "Comments." Put anything in this space that will facilitate the analysis, or anything you believe to be material.

Transmittal

Do not wait to send in the completed interviews. As they are completed, forward them to the Jorgensen office for analysis.

We will be handling a lot of paper. We need as much time as possible to pull the information together and to prepare the final reports.

Any questions should be directed to any one of the following:

Lance Stapleton, Roy Jorgensen Associates, Inc.
OR
Ed Shaw, Roy Jorgensen Associates, Inc..
OR
Don Ammons, Roy Jorgensen Associates, Inc.
State Highway Commission
Helena, Montana 59601
PHONE 406/449-2056

OR

Dean Zinnecker, Administrative Assistant
State Highway Commission
Helena, Montana 59601
PHONE 406/449-2568

Completion

We need all data by 1-15-71 , but don't wait. The sooner, the better!

SALARY SURVEY
CASE PROBLEM

Instructions

Attached are the forms you will need to make a practice run in completing the data required for the salary survey. Use the information below to make all necessary entries. Assign the employers identification number, complete the EMPLOYER AND FRINGE BENEFITS QUESTIONNAIRE (form 1) and the necessary number of SALARY SURVEY QUESTIONNAIRE (form 21).

Apply all the things we have talked about. When the group has completed we will go over the way the forms would best be completed.

Firm Name and Address

LO SAL REES, INC.
P. O. Box 929
Big Sky, Montana

Type of Firm

Engineering Consultants specializing in all types of design work -- foreign and domestic.

Interview Sequence

Five interviews have been completed in this district, district three, before we started on this one.

Company Size

The firm employs 30 people on a full-time basis. In June they start to hire temporary and part-time people to meet their increased work load. They normally have a maximum of 20 additional people in these classifications. The peak is usually reached in August.

Working Hours

The company has a mixed working hours schedule. Engineers and Technicians work 48 hours per week. Clerks work 35 hours per week. The Engineers and Technicians work a six day week, 8 hours per day. Clerical personnel work a five day week, 7 hours per day.

Overtime

Clerks don't get much overtime but when they do they get compensatory time off no matter when they work.

Engineers are professionals hired to do a job. They are expected to work the hours necessary to complete the job without additional compensation of any kind. They probably average 180 hours per year.

Technicians get overtime payment and they work a lot of overtime, most of them get around 300 hours per year. Anything over 40 during the week is on a time and one-half compensatory time basis. Saturday work is time and a half cash and Sundays and holidays are cash at a double time rate.

Leave

The office is closed five days per year for holidays, but employees are not paid those days unless they work.

All employees earn five days of paid sick leave per year. After they use that they are on leave without pay.

All employees earn annual leave, the amount they earn depends upon how long they have been with us. Those with 5 years or less of service earn ten days per year. With six to ten years they earn 15 days. With more than ten years they earn 20 working days per year. All annual leave is paid.

Bonuses and Raises

Last year the President and Vice President voted themselves a 10 percent bonus. The balance of the employees got a new $10 bill and a bottle of Old Sweat Socks bourbon.

All employees got one raise last year but the amounts varied considerably. I would estimate that the bosses got another 10 percent, clerks probably got 5, the engineers got 8 and the technical people got around 15, they have been moving real fast.

Retirement and Insurance

Our retirement plan has two parts, Social Security and our own plan. We pay 4.8 percent of the employees salary into Social Security up to $7,700 per year. Ten percent of the employees salary is paid into retirement--he pays 5 percent and the company pays 5%. The company limits their contribution to $1,000 per year per employee.

We pay one individual's share of the health insurance plan, right now that is $17 per month. If the employee wants a family plan he pays the difference. Right now the family plan is $35 per month.

The guys got together on a group life insurance plan and most employees belong. They get $1,000 coverage for $4 per month. Most are carrying $5,000 policy. The company does not pay any of the cost.

Travel Time

Our employees are on the job when their work day starts and don't leave until it is complete.

Rates of Pay

We have established a personnel classification and salary plan. We have eight personnel classifications--President, Vice President, Project Manager, Project Engineer and Head Technician, Technician, Clerks and Part-time.

President

The range in pay for the President is $25,000 to $30,000 per year. He is responsible for the company. He does all selling, planning, organizing and controlling a relatively small consulting firm. He is head of the outfit and his salary shows it. He is now making $29,000 per year.

Vice President

He's the bosses son. His primary job is girl chasing, boozing and playing golf. The salary range for the job is $19,000 to $23,500. But he is never around here. The boss gives him $15,000, he doesn't earn $2,000.

Project Managers

Our project managers are our top engineers. Salary ranges are from $16,500 to $20,000. They are responsible for several design projects at one time. They do their own scheduling and the Project Engineers, who head up the design crews, are responsible to them. Each project manager has 3 Project Engineers responsible to him. Both of the men are long term employees. One earns $19,600 and the other makes $18,400.

Project Engineers

We have two new project engineers who are just learning. They graduated from college this spring. They have not yet taken over a design crew. One replaces a man

who quit last spring. The other is on a new crew we are organizing.

Our range for Project Engineer is $8,400 to $15,000. The two new men are both earning $9,000.

The balance of our project engineers are experienced people. They are given any design job and handle it from beginning to end. They usually have 2 to 5 people on their crews. These guys are fully qualified design engineers in every respect. One is earning $15,000, one is earning $13,000 and two are at $12,000. All of our engineers are graduates. These four have their P.E.

Head Technicians

Our head technicians are good men who have been with us a long time. They are not engineers but they can handle routine jobs with little assistance, but they get help from the project engineers on the tougher problems. There is one of these men to a design crew. They are paid on a monthly basis. The salary range is from $600 to $1,000 per month. Two men earn $950, one earns $900, two earn $800 and one earns $750. We have had no turnover in this group since Steve retired in 1968.

Technicians

Our technicians cover a lot of kinds of people. We have two new high school graduates doing very routine work -- most of it is drafting, but they do some calculator work. We pay these kinds of people from $400 to $700 per month. These two guys are at $400.

We just picked up two young graduates from a two year pre-engineering training course. They are doing pretty routine stuff but learning fast. They are at $475.

We have 5 men who are pretty well qualified draftsmen and detailers. They do very simple design work under close supervision. Two men draw $525, one is at $575, one is at $600 and one is at $625.

We have three men at the top of our technician group. They all earn $650 per month. They do top level difficult drafting, simple design without much supervision and some intermediate level design under very close supervision.

We have had some trouble keeping this kind of people. We lost 4 last year.

Clerks

Our clerks are typists primarily but do general office work as well including bookkeeping, filing and some general office management. We pay them $200 per month. Both were hired in the last six months to replace two gals we lost. Their salary range is $175 to $225 per month.

Part-Time

The part-time people are high school graduates and some students on summer vacation. We pay from $1.75 to $2.25 per hour. We only have three on the payroll now. One at $1.75, one at $2.00 and one at $2.25. These men perform only very routine drafting and calculating work. They also do any errands, etc. we might have.

THE END -- LOOK UP WHEN YOU ARE DONE

Form 1 Identification Number_____

EMPLOYER AND FRINGE BENEFITS QUESTIONNAIRE

This questionnaire is designed to furnish basic information about employees, working conditions and fringe benefits offered to employees.

COMPANY OR AGENCY SIZE:

Total number of permanent employees_____

Number of seasonal employees at peak level_____

Month of peak seasonal employment_____

If private company doing business in states other than Montana list the total number of permanent employees in Montana_____

REGULAR WORKING HOURS PER WEEK:

If all employees are on the same work week, check the number of regular hours worked per week below and skip to OVERTIME HOURS.

35_____, 37½_____, 40_____, Other _____ (indicate hours)

If the work week varies for different types of employees, check the appropriate spaces below:

Clerical and Office:

35_____, 37½_____, 40_____, Other _____ (indicate hours)

Mechanical and Trades:

35_____, 37½_____, 40_____, Other _____ (indicate hours)

Technical and Field:

35_____, 37½_____, 40_____, Other _____ (indicate hours)

Professional:

35_____, 37½_____, 40_____, Other _____
(indicate hours)

OVERTIME HOURS:

If all employees are paid overtime on the same basis, check the basis of overtime payment in the appropriate space below and skip to OVERTIME FREQUENCY:

	----STRAIGHT---- TIME		----TIME AND---- ONE-HALF		----DOUBLE---- TIME	
	Cash	Compensatory	Cash	Compensatory	Cash	Compensatory
Weekdays	____	_____	____	_____	____	_____
Saturdays	____	_____	____	_____	____	_____
Sundays/ Holidays	____	_____	____	_____	____	_____

If varying overtime plans are used for different classifications of employment, check the basis of overtime payment in the appropriate space below:

	----STRAIGHT---- TIME		----TIME AND---- ONE-HALF		----DOUBLE---- TIME	
	Cash	Compensatory	Cash	Compensatory	Cash	Compensatory
Clerical and Office:						
Weekdays						
Saturdays	____	_____	____	_____	____	_____
Sundays/ Holidays	____	_____	____	_____	____	_____
	____	_____	____	_____	____	_____
Mechanical and Trades:						
Weekdays						
Saturdays	____	_____	____	_____	____	_____
Sundays/ Holidays	____	_____	____	_____	____	_____
	____	_____	____	_____	____	_____

Technical and Field:

Weekdays	____	_____	____	_____	____	_____
Saturdays	____	_____	____	_____	____	_____
Sundays/ Holidays	____	_____	____	_____	____	_____

Professional:

Weekdays	____	_____	____	_____	____	_____
Saturdays	____	_____	____	_____	____	_____
Sundays/ Holidays	____	_____	____	_____	____	_____

OVERTIME FREQUENCY:

Indicate the amount of overtime that the average employee works in a year's time:

	None or Rare	20 to 50 hours	51 to 100 hours	101 to 150 hours	More than 150 hours
Clerical & Office	_____	_____	_____	_____	_____
Mechanical & Trades	_____	_____	_____	_____	_____
Technical & Field	_____	_____	_____	_____	_____
Professional	_____	_____	_____	_____	_____

PAID HOLIDAYS GIVEN PER YEAR:

How many paid holidays are given your employees per year?

_____
(enter number of days)

PAID DAYS OF SICK LEAVE EARNED PER YEAR:

If all employees earn paid sick leave at the same rate, enter the number of days earned per year here_____.

If employees are allowed to take paid sick leave but there is no established earning rate, check here_____.

If there is no allowance for paid sick leave, check here_____.

If the amount of paid sick leave earned depends on the years of service of the employee, write the years of service in the left-hand column and the earning rate in the right-hand column:

---Years of Service---		Earning Rate (Days per Year)
From	To	
0		

PAID DAYS OF VACATION EARNED PER YEAR:

If all employees earn vacation at the same rate, enter the number of days earned per year here_____.

If there is no paid vacation allowance, check here_____.

If the amount of paid vacation depends on the years of service of the employee, write the years of service in the left-hand column and the earning rate in the right-hand column.

---Years of Service---		Earning Rate (Days per Year)
From	To	

BONUSES:

If bonuses are given to employees, indicate the average amount or percent of annual salary. If this varies depending on profits, give data for last year.

	- - - - Average amount of Bonus - - - -
Administrative	____percent of annual salary or $_____
Office & Clerical	____percent of annual salary or $_____
Mechanical & Trades	____percent of annual salary or $_____
Technical & Field	____percent of annual salary or $_____
Professional	____percent of annual salary or $_____

SALARY INCREASES:

Check the average number of raises given during the past year.

	- - - Number of Raises Per Year - - -		
	None	One	Two
Administrative	_____	_____	_____
Office & Clerical	_____	_____	_____
Mechanical & Trades	_____	_____	_____
Technical & Field	_____	_____	_____
Professional	_____	_____	_____

Check the average amount of raises given during the past year.

	- - - Average Amount of Raise - - - - -			
	Less than 3%	3% to 5%	6% to 8%	Over 8%
Administrative	_____	_____	_____	_____
Office & Clerical	_____	_____	_____	_____
Mechanical & Trades	_____	_____	_____	_____
Technical & Field	_____	_____	_____	_____
Professional	_____	_____	_____	_____

RETIREMENT CONTRIBUTIONS BY EMPLOYER:

Enter the employer retirement contributions, other than Social Security, made for employees. _____% of the employees salary up to (if applicable) a maximum of $_____ or _____% of salary per year.

EMPLOYER INSURANCE CONTRIBUTIONS:

Indicate if the employer pays any of the costs of employee insurance plans and the amount of payment, if applicable.

	Yes	No	Amount
Health plan	____	____	$_____per month
Life Insurance Plan	____	____	$_____per month

TRAVEL TIME:

Indicate the employers practice in travel time. Include only time from duty station to work location, not from home to duty station.

	On Employees Time	On Employers Time	One-Way on Employers Time
Mechanical & Trades	_____	_____	_____
Technical & Field	_____	_____	_____
Professional	_____	_____	_____

OTHER FRINGE BENEFITS:

Briefly describe any other major fringe benefits afforded to your employees.

_____

_____

_____

_____

_____

Form 21 Identification Number ___ - ___ - ___

SALARY SURVEY QUESTIONNAIRE

THEIR PERSONNEL CLASSIFICATION TITLE: _____

DESCRIPTION OF DUTIES: _____

_____

_____

_____

_____

_____

YOUR PERSONNEL CLASSIFICATION: _____

Number of Employees	Actual Salaries	Per
_____	$_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Turnover Rate Per Year _____

SALARY SURVEY

Total number of firms reporting	55
Total employees of the firms reporting	19,000

Bases for employer selection

1. Successful recruitment at the state colleges and technical schools.
2. Successful recruitment in the Highway Department.
3. Leading employers in Montana that have jobs comparable with Highway Department jobs.

NUMBER AND TYPE OF EMPLOYERS

PARTICIPATING IN SURVEY

TYPE OF EMPLOYER	NUMBER OF EMPLOYERS	PERCENT OF TOTAL
Industry and Utilities	3	6
Contractors	31	56
Federal Government	4	7
Other State Agencies and Local Governments	3	6
Services*	14	25
TOTAL	55	100

*Services includes engineering consultants.

SALARY SURVEY FINDINGS

DISTRIBUTION OF SALARIES PAID TO ENGINEERS

CLASSIFICATION	Total Salary Range	Prevailing Range	Prevailing Average Salary	Difference Dollars	Difference Percent
ENGINEER-IN-TRAINING					
Salary Survey	8,000 - 12,900	8,000 - 11,900	9,100	--	--
Preconstruction	8,800	8,800	8,800	- 300	- 3%
ENGINEER I					
Salary Survey	9,700 - 18,900	11,900 - 16,600	14,600	--	--
Preconstruction	9,200 - 9,600	9,200 - 9,600	9,500	- 5,100	- 35
ENGINEER II					
Salary Survey	11,200 - 24,000	15,000 - 19,200	16,100	--	--
Preconstruction	11,000 - 14,400	11,000 - 14,400	12,200	- 3,900	- 24
ENGINEER III					
Salary Survey	14,400 - 21,800	14,400 - 21,800	16,700	--	--
Preconstruction	11,600 - 14,500	11,600 - 14,500	13,000	- 3,700	- 22
ENGINEER IV					
Salary Survey	15,600 - 39,600	19,800 - 27,500	22,300	--	--
Preconstruction	17,500 - 20,000	17,500 - 20,000	18,800	- 3,500	- 16

SALARY SURVEY FINDINGS

DISTRIBUTION OF SALARIES PAID TO TECHNICIANS

--- MONTHLY SALARIES ---

CLASSIFICATION	Total Range	Prevailing Range	Prevailing Average	Difference Dollars	Difference Percent
TECHNICIAN I					
Salary Survey	380 - 550	430 - 510	500	-	-
Preconstruction	470 - 560	470 - 560	500	-	-
TECHNICIAN II					
Salary Survey	440 - 740	500 - 650	570	-	-
Preconstruction	540 - 740	540 - 740	625	+ 55	+ 9
TECHNICIAN III					
Salary Survey	530 - 1,010	600 - 790	650	-	-
Preconstruction	640 - 800	640 - 800	740	+ 90	+ 13
TECHNICIAN IV					
Salary Survey	580 - 1,080	680 - 910	820	-	-
Preconstruction	780 - 870	780 - 870	805	- 15	- 2
TECHNICIAN V					
Salary Survey	710 - 1,260	850 - 1,260	1,010	-	-
Preconstruction	810 - 950	810 - 950	890	- 120	- 12

CONDITIONS OF EMPLOYMENT SURVEY

SUMMARY STATEMENTS

HOURS IN REGULAR WORK WEEK

Well over three fourths of employers have 40 hour work weeks for engineering and technical employees.

The Highway Department has a 40 hour week.

OVERTIME PAYMENTS

Technical personnel are paid time and one-half by 80 percent of the employers. Professional personnel are paid time and one-half by 35% of employers.

The Highway Department pays time and one-half to technical personnel up through the G-17 level. Higher level technician employees receive monthly overtime payments at standard rates. Professional employees receive no overtime pay.

OVERTIME HOURS WORKED

Fifty six percent of technicians in business and industry work more than 100 hours per year. Seventy one percent work more than 50 hours per year. Seventy three percent of the professionals work more than 50 hours per year.

Highway Department technicians in Helena rarely work overtime while the field technicians average more than 50 hours per year.

HOLIDAYS

In business and industry 95 percent of employers provide paid holidays. The average number provided is 7.

Highway employees receive 10 paid holidays per year plus election days and other holidays declared by the Governor.

HEALTH AND LIFE INSURANCE

Over 90 percent of employers provide some type of health insurance plan for their employers. The average employer participation if $22.00 per month per employee.

About half of the employers provide life insurance plans -- usually as part of the health plan.

The Highway Department provides group health and life insurance coverage for its employees. The Department's current contribution to costs is $7.50 per month. This contribution will increase to $10.00 per month effective July 1, 1971.

PAID VACATIONS

Paid vacations are provided by ninety one percent of employers. Those that provide paid vacations are divided between constant amounts regardless of seniority and graduated amounts based on length of service.

The Highway Department provides paid vacation on a sliding scale -- 15 days per year for the first 10 years of service and ranging up to 24 days per year for over 20 years of service.

SICK LEAVE

Paid sick leave is provided by 84 percent of employers. Some employers use graduated scales based on length of service -- some use the flat rate regardless of seniority. A significant number -- 34 percent -- do not use a schedule for accrual or use of sick leave.

The Highway Department provides 12 days per year paid sick leave with unlimited accumulation provisions.

RETIREMENT

Retirement plans in addition to Social Security are provided by approximately 40 percent of employers. The average employer contribution is 7 percent of salary.

Highway Department employees are covered by Social Security and the Public Employees Retirement System. Department participation currently is 4.3 percent of salary and is scheduled to reach 5.2 percent by July 1, 1975.

BONUS PAYMENTS

About half of the private (non-government) employers provide bonuses for some or all of their employees. The average bonus payments to technicians is $540 per year. The average bonus payments to professionals is $1,240 per year.

No bonuses are paid to Highway Department employees.

IMPROVED PERSONNEL CLASSIFICATION

AND

SALARY PLANS

SUMMARY DEFINITIONS OF THE CLASSIFICATIONS IN THE PROPOSED CLASSIFICATION PLAN FOR ENGINEERS AND TECHNICIANS

CLASSIFICATION TITLE	SUMMARY DEFINITION
Chief Engineer	Directs the total Department activity within the framework of law, Commission plans and policies and budgets; recommends long-range highway system improvements based on needs and finances, adopts basic engineering policies and standards and provides continuing direction to engineering work underway.
Management Engineer	Develops long-range highway system improvement programs in such areas as needs and finances, preconstruction development, materials quality control, construction and maintenance; plans and organizes Department functions as necessary to implement adopted programs; reviews and approves, rejects or recommends exceptions to policies and standards.
Administration Engineer	Organizes manpower and equipment, adopts operating policies, develops systems and procedures, and provides administrative direction to such activities as the Bureau of Road Design or the Bureau of Bridge Design.
Executive Engineer	Provides day-to-day direction to programs underway, always in compliance with operational policies and standards; reviews and makes recommendations on organization, system and procedure changes as necessary effectively to execute adopted programs.
Senior Engineer Senior Manager	Supervises project level personnel, making adjustments in manpower, equipment and schedules within assigned projects as necessary to insure an overall balance between work loads and performance capabilities; serves as an authoritative specialist subject to administrative but little technical direction and review.

CLASSIFICATION TITLE	SUMMARY DEFINITION
Project Engineer Project Manager	Initiates, controls and completes undertakings within a carefully defined framework of project objectives, plans, specifications, staffing, schedules and budgets; makes judgemental decisions within project guidelines, but submits recommendations to higher authority on matters not in compliance with established controls.
Engineer	Performs assistant project level work as necessary to the development of project management capability; usually works with project level personnel who have demonstrated capabilities to develop project managers.
Senior Technicians	Supervises major segments of project activities under the control of project level personnel.
Technician III Technician II Technician I	Performs technical work within individual capabilities as assigned.

CLASSIFICATION STATEMENT

CHIEF ENGINEER

Summary Definition

Serves as the Chief Engineering Officer of the Department and directs the total Department activity within the framework of law, Commission plans, policies and budgets; recommends long-range highway system improvements based on needs and finances, adopts basic engineering policies and standards, and provides continuing direction to engineering work underway.

RESPONSIBILITIES UPWARD

Reports system needs and finances.

Recommends long-range program.

Recommends current (2 to 5) years program.

Recommends legislation, basic Department policies and Department manpower plan.

RESPONSIBILITIES DOWNWARD

Provides guidance and direction in the development of long-range and current highway improvement programs and management recommendations.

Provides general engineering objectives and schedules.

Provides basic engineering policies and standards and makes final decision on exceptions.

MINIMUM QUALIFICATIONS

Registration as a professional engineer in the State of Montana
AND
The capability to manage, with only basic direction, a large engineering organization with the scope of programs and complexities of operations of that of the Montana Department of Highways
AND
Three years of experience at the mangement, administrative or executive levels of a complex engineering organization.

CLASSIFICATION STATEMENT

MANAGEMENT ENGINEER

Summary Definition

Develop long-range highway system improvement programs in such areas as needs and finances, preconstruction development, materials quality control, construction and maintenance; plans and organizes Department functions as necessary to implement adopted programs; reviews and approves, rejects or recommends exceptions to policies and standards.

RESPONSIBILITIES UPWARD

Reports results of highway needs and finance studies.

Reports results of highway management studies.

Recommends long-range and current (2 to 5) years programs.

Recommends manpower management program based on long-range and current needs.

Recommends changes in the overall organization of the engineering function.

RESPONSIBILITIES DOWNWARD

Provide long-range and current program assignments, together with major schedule dates, policies, standards, budgets and other control data.

Provide assistance on matters that, unless resolved, will result in non-attainment of Department objectives, programs and schedules.

MINIMUM QUALIFICATIONS

Demonstrated capability to plan, organize, direct and control a major engineering section -- preconstruction or operation -- of the Montana Department of Highways in accordance with the personnel classification plan
AND
Registration as a professional engineer in the State of Montana
AND
Three years of progressively responsible experience at the Administrative, Executive and/or Senior levels of an engineering organization comparable in complexities to the Montana Department of Highways.

CLASSIFICATION STATEMENT

ADMINISTRATIVE ENGINEER

IN

PRECONSTRUCTION DIVISION

Summary Definition

Administrative Engineers organize manpower and equipment, adopt operating policies, develop systems and procedures and provide administrative direction to the Bureau of Road Design or the Bureau of Bridge Design.

RESPONSIBILITIES UPWARD

Report operational programs, schedules, organizations, policies and standards adopted to carry out Department objectives, programs and schedules.

Report exceptions to received policies, schedules and standards.

Report operational progress.

Report future manpower, equipment, budget and other needs.

RESPONSIBILITIES DOWNWARD

Develop operation organization in terms of work load and the relationships between work load and the staffing pattern.

Adopt operational policies.

Adopt systems and procedures.

Establish production schedules.

Evaluate organizational performances.

Manage personnel and training program.

Insure that policy implementation in operation are consistent with the same and similar implementations in other operations.

Establish working relationships with other operational and organization units.

Establish and maintain appropriate relationships between operational and other government agencies, industry and the public.

MINIMUM QUALIFICATIONS

Demonstrated capability to effectively manage a major bureau of the Montana Department of Highways within the policy and program direction of top management
AND
Registration as a professional engineer in the State of Montana
AND
Three years of progressively responsible experience at the Executive, Senior and/or Project levels of an engineering organization.

CLASSIFICATION STATEMENT

EXECUTIVE ENGINEER

IN

PRECONSTRUCTION DIVISION

Summary Definition

Executive Engineers provide day-to-day direction to programs underway, always in compliance with operational policies and standards; they review and make recommendations on organization, system and procedure changes as necessary effectively to execute adopted programs.

RESPONSIBILITIES UPWARD

Report exceptions to operational policies, standards, procedures, staffing patterns and budget schedules.

Report status of operational activities underway.

Report needs for new agreements, legal assistance, specialist engineer assistance and comparable needs from other functions and agencies.

Report organizational performances and evaluations of individual performances.

RESPONSIBILITIES DOWNWARD

Develop project assignments and continuing individual responsibilities for Senior level personnel.

Develop appropriate staffing patterns in terms of work loads and the numbers and types of persons needed to accomplish the work load.

Provide operational policies, standards, schedules and relationships.

Make decisions and/or obtain decisions from higher authority, on exceptions to policies, standards, schedules and similar items.

Authorize the hiring and placing of manpower, the purchase of budgeted equipment and the performance of all work that meets the requirements of the operational plan.

Provide evaluations of performances.

MINIMUM QUALIFICATIONS

Demonstrated capability to make judgmental decision in the initiation, conduct and completion of major operational assignments
AND
Demonstrated capability to execute road preconstruction plans and programs
AND
Registration as a Professional Engineer in Montana
AND
Two years of progressively responsible experience at the Senior and/or Project Engineer levels in an engineering organization whose activities are directly related to the proposed assignments.

CLASSIFICATION STATEMENT

SENIOR ENGINEER
SENIOR MANAGER

IN

PRECONSTRUCTION DIVISION

Summary Definition

Senior Engineers and Senior Managers supervise project level personnel; they make adjustments in manpower, equipment and schedules within assigned projects as necessary to insure an overall balance between work loads and performance capabilities; they serve as an authoritative specialist subject to administrative but little technical direction and review.

RESPONSIBILITIES UPWARD

Report the initiation of projects, the general progress of each project and the completion of each project.

Report exception to policies, standards, schedules, contract terms and similar items; submit recommended changes or administrative action to higher management; report administrative actions initiated.

Evaluate work done, work status, organization performances and individual performances.

Recommend changes in or exceptions to operational policies, standards and procedures.

RESPONSIBILITIES DOWNWARD

Provide guidance, assistance, direction and coaching to project level personnel.

Review status of each project, potential for meeting adopted schedules, manpower needs in relation to manpower assigned, adequacy of project supervision and control, and the need for specialized guidance or senior engineer assistance; allocate manpower based on these considerations.

Report and interpret management decisions on manpower, equipment, schedules, budgets and other requests.

MINIMUM QUALIFICATIONS

SENIOR ENGINEER - Demonstrated capability to manage numerous projects and project supervisors simultaneously
AND
Three years of successful experience at the project level
OR
A masters or doctorate degree in a field directly related to the types of assignments to be made.

SENIOR MANAGER - Demonstrated capability to manage numerous projects and project supervisors simultaneously
AND
Three years of successful experience at the project level.

CLASSIFICATION STATEMENT

PROJECT ENGINEER
PROJECT MANAGER

IN

PRECONSTRUCTION DIVISION

Summary Definition

Project Engineers and Project Managers initiate, control and complete undertakings within a defined framework of project objectives, specifications, staffing, standards, schedules and budgets; make judgemental decisions within project guidelines but submit recommendations to higher authority on matters not in compliance with established controls.

RESPONSIBILITIES UPWARD

Reports project progress.

Reports project completion.

Reports items in exception to project framework; prepares and submits recommendation for problem solution.

Request needed manpower and equipment.

RESPONSIBILITIES DOWNWARD

Provides direction and supervision to one or more projects as assigned.

Analyzes each project in terms of the objectives, requirements for completion and the manpower needed.

Organizes manpower, making best use of the performance capability of each person for doing work and developing additional capability.

Maintain records of work done and other data pertinent to project characteristics and progress.

MINIMUM QUALIFICATIONS

PROJECT ENGINEER - Demonstrated capability to manage projects of the unit to which assigned
AND
Six months successful experience as an Engineer.

PROJECT MANAGER - Demonstrated capability to manage projects of the unit to which assigned
AND
Demonstrated capability to perform at least 90 percent of the tasks of the unit to which assigned
AND
Two years successful experience at the Senior Technician level.

CLASSIFICATION STATEMENT

ENGINEER

Summary Definition

Performs assistant project level work as necessary to the development of project management capability; usually works with project level personnel who have demonstrated capabilities to develop project managers.

Work Assignments

Engineers are assigned to project or senior engineers selected for their unique abilities to develop project engineers.

Work performed on these assignments may include anything from clerical tabulation and routine technical tasks to the temporary management of a project -- but each assignment is based on the individual needs of the engineer. A complete understanding of the responsibilities of the project engineer and of the details of work performance essential to the successful completion of a project are essential.

Work performed includes that need to provide experience in several elements of the training set forth below.

Training Assignments

Engineers are given on-the-job training with regard to the following:

A. Orientational elements.

1. Knowledge of Department objectives, needs, finances, programs, basic policies and accomplishments.

2. Knowledge of the general department organization and organization relationships.

3. Knowledge of the functions, organization and basic policies and procedures of the division or district to which the employee is assigned.

4. Knowledge of the relationships between the Department and the Governor, Legislature, Bureau of Public Roads, other states, counties, municipalities, contractors and public.

B. Technical elements.

1. Knowledge of the basic technology of highway planning, design, construction and maintenance.

2. Detailed knowledge of the technology of the operation to which the employee is assigned -- of soils and aggregates, basic sampling and testing, contract plan reading and basic surveying, for example, if the employee is assigned to construction inspection.

3. Detailed knowledge of the written guides and controls over the work performed -- manuals, directives, standards, procedures.

C. Project management elements.

1. Ability to analyze a project in terms of its objectives, the time requirements for completion, the number of personnel needed and the skills of those personnel, and the numbers and types of equipment needed.

2. Ability to set up project records and controls -- systems of files, progress reports and reports of non-compliance with plans, specifications and standards.

3. Ability to organize the project manpower and equipment, making best use of the performance capability available and developing additional capability.

4. Ability to delegate and control elements of the work so that project management attention can be directed at each work element in need of attention.

5. Ability to make judgmental decisions within the framework of approved objectives, standards, schedules, staffing arrangements and budgets.

6. Ability to recognize the need for higher level assistance to change any part of the project framework, and for specialized assistance in making technical decisions within the project framework.

7. Ability to complete the project as planned and approved.

MINIMUM QUALIFICATIONS

Registration in the State of Montana as a professional engineer or possession of an engineer-in-training certificate, or a degree in a directly related engineering field.

CLASSIFICATION STATEMENT

SENIOR TECHNICIAN

IN

PRECONSTRUCTION DIVISION

Summary Definition

Senior Technicians supervise major segments of project activities under the control of project level personnel; make decisions within guidelines set forth by supervisor.

RESPONSIBILITIES UPWARD

Reports exceptions to project controls and standards.

Reports progress and completion on work items.

Requests additional manpower and equipment as needed to complete work items on schedule.

Reports surplus manpower and equipment as they occur.

Reports training needs of employees assigned.

RESPONSIBILITIES DOWNWARD

Supervises major elements of projects.

Supervise total minor projects without project management authority and responsibility.

Provides on-the-job training for subordinate technicians.

MINIMUM QUALIFICATIONS

Demonstrated capability to supervise projects for several days with guidance only on unusual problems
AND
Demonstrated capability to perform at least 65 percent of the tasks of the unit to which assigned
OR
Demonstrated capability to perform all level one, level two and level three activities plus four level four or level five activities.

CLASSIFICATION STATEMENT

TECHNICIAN III
TECHNICIAN II
TECHNICIAN I

IN

PRECONSTRUCTION DIVISION

Summary Definition

Performs technical work within individual capability as assigned.

RESPONSIBILITIES UPWARD

Reports work performed, status of work underway and situations needing higher level attention.

Reports assignments received that cannot be carried out for lack of data, assistance or equipment.

RESPONSIBILITIES DOWNWARD

Perform technician level work as assigned.

Takes training to develop improved capability.

MINIMUM QUALIFICATIONS

TECHNICIAN III - Demonstrated capability to perform at least 35 percent of the tasks of the unit to which assigned
OR
Demonstrated capability to perform all level one and level two activities plus three level three or four activities.

TECHNICIAN II - Demonstrated capability to perform at least 10 percent of the tasks of the unit to which assigned
OR
Demonstrated capability to perform all level one activities and two level two or level three activities.

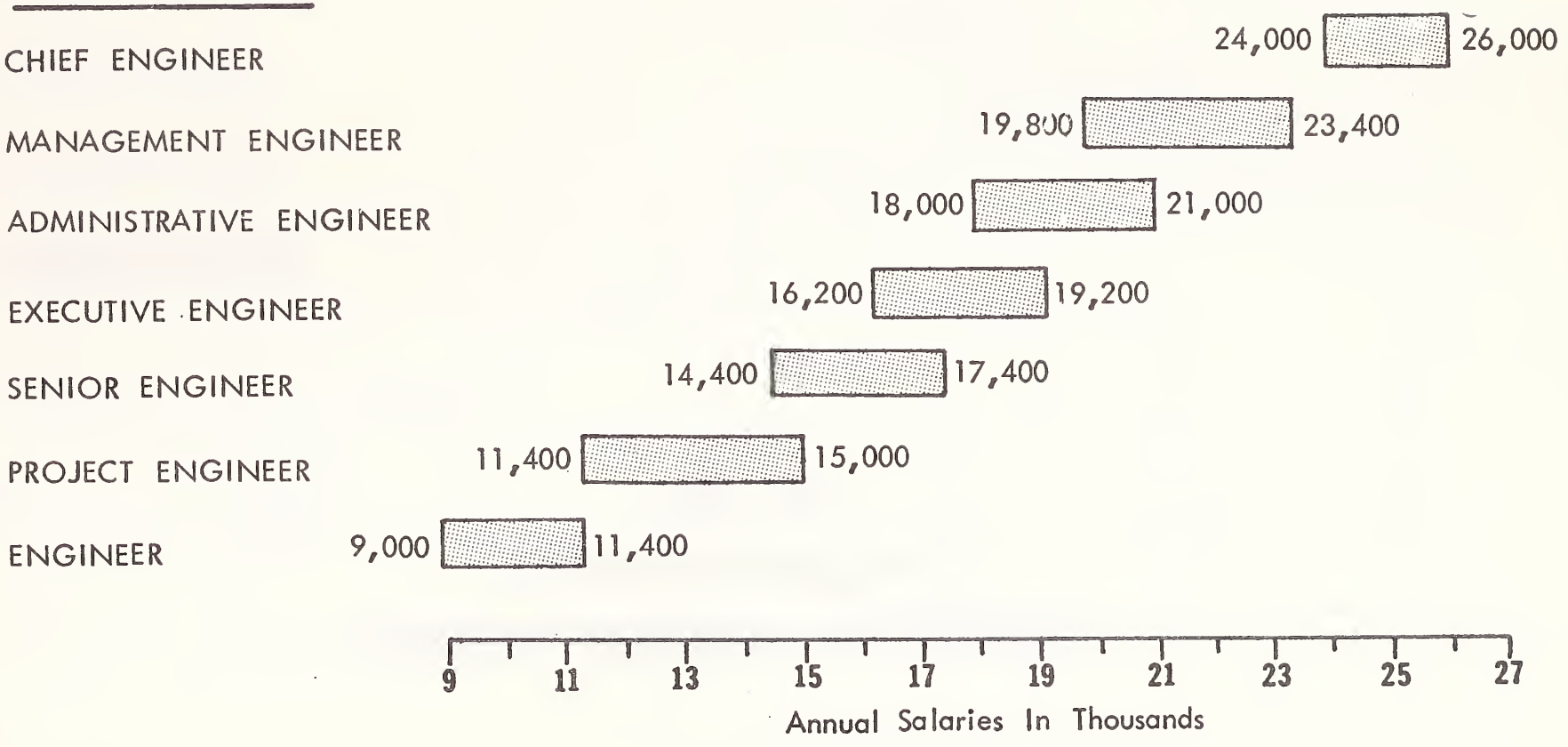
TECHNICIAN I - At least 18 years of age
Good personal record
Aptitude, interest and physical capabilities consistent with the work.

ACTIVITIES BY LEVEL OF DIFFICULTY

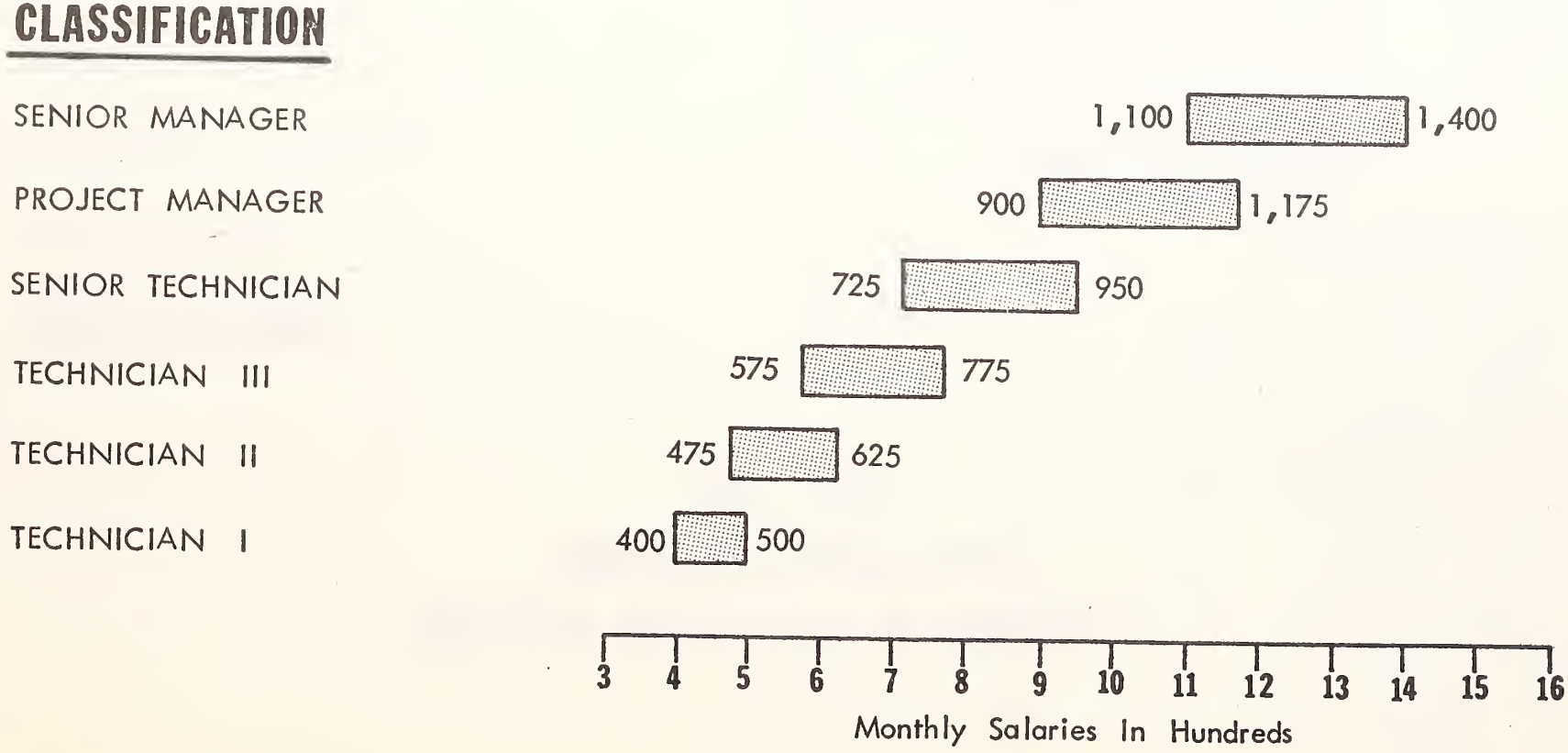
LEVEL	ROAD DESIGN	TRAFFIC
1	Plot cross-sections Compute areas Plot mass diagrams Inking and tracing Plot construction limits Prepare ROW linens	Prepare plan view of roadway Prepare guide sign plan sheet Code computer inputs Prepare title sheet or summary sheets Operate remote terminal
2	Plot survey data Compute grade lines Plot drainage Prepare displays & illus. Compute earthwork Code basic computer inputs Extend estimates and quantities Prepare utility plans Determine theoretical crush-down Develop standard city agreements Prepare bid summaries	Plot data from sketch Determine layout of standard control devices Prepare speed zone folders Prepare crash diagrams
3	Check notes preparatory to plotting Template cross-sections Design clearing and grubbing Compute ROW areas of taking Compute final quantities Cross-check road & bridge plans Prepare ROW sepias Review consultant agreements Prepare engineers estimate Prepare proposal package Prepare for letting Conduct letting & evaluate bids	Develop cost estimates Prepare or check quantity sheets
4	Design contour grading Design miscellaneous features Design fencing Check & interpret computer runs Design ROW limits Determine soil support values Prepare modified estimate Compile & review standard drawings	Review approach permits Develop phase diagrams Design guide and unusual signs Develop signal and lighting layout Prepare progress reports

LEVEL	ROAD DESIGN	TRAFFIC
5	Design typical sections Design alignment & grade Design intersections, interchanges, etc. Design drainage Prepare preliminary estimates Write preliminary special provisions Code complex computer inputs Interpret and plot property lines Check & review plans Design structural sections Select materials sources Develop contract bid item list Develop special city agreements Write final special provisions Present project to Board of Review Prepare reports + Supporting Requirements	Check electrical design plans Develop timing schedules Determine need for signalization Prepare preliminary special provisions Design traffic facilities related to roadway geometrics Determine adequacy of existing facilities Check plans Develop wiring layout Prepare or check design of control structures + Supporting Requirements

MONTANA DEPARTMENT OF HIGHWAYS
ENGINEER SALARY PLAN
JUNE 1971



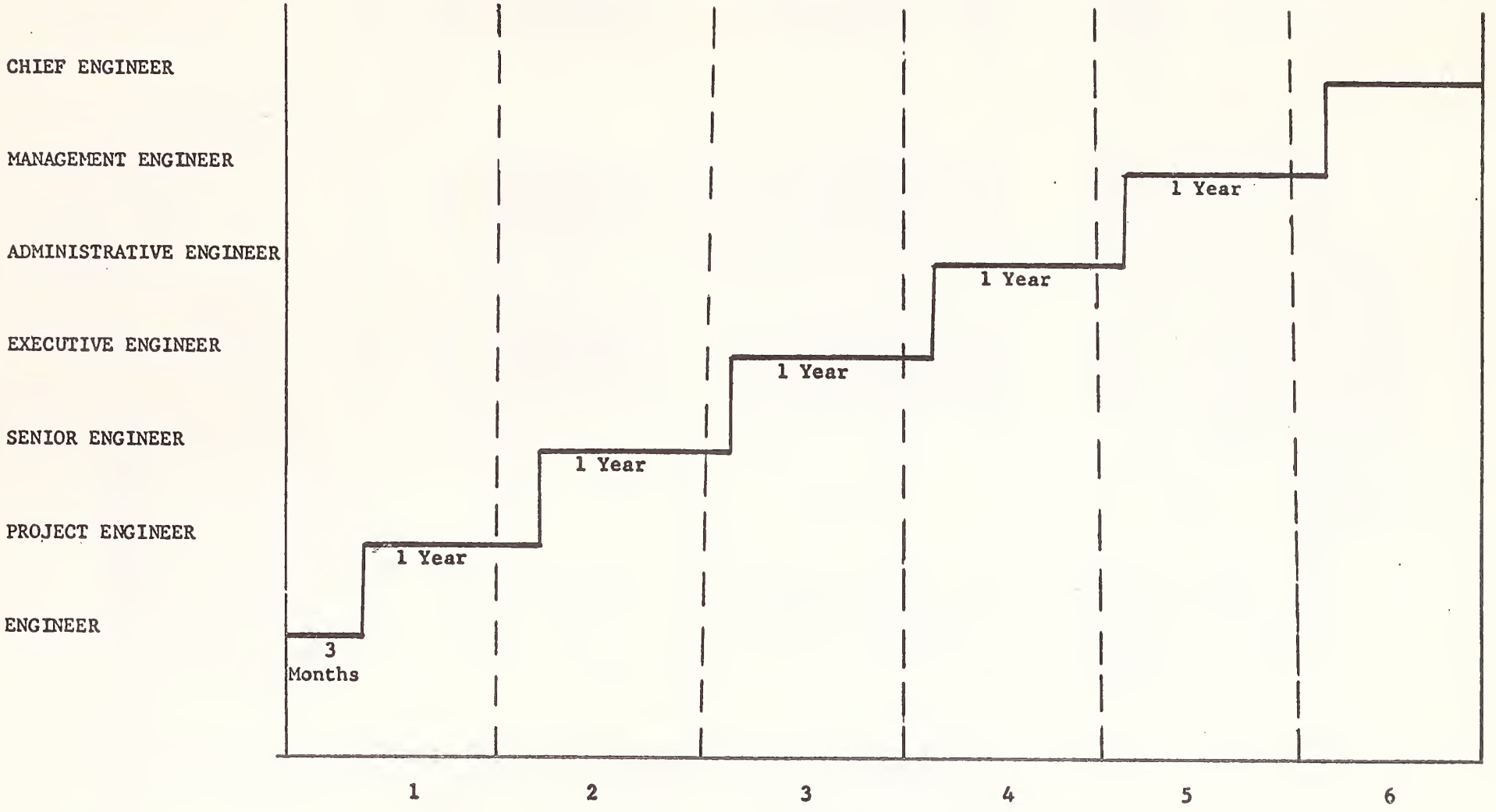
MONTANA DEPARTMENT OF HIGHWAYS
TECHNICIAN SALARY PLAN
JUNE 1971



ENGINEERS

MAXIMUM RATE OF PROGRESSION

UNDER PERSONNEL CLASSIFICATION PLAN



PRECONSTRUCTION
EVALUATION RESULTS
FOR TOTAL PLAN IMPLEMENTATION

June 1971

	No. of Persons	---- Annual Cost--- Current	Proposed	Average Annual Increase Amount	Percent
TECHNICIANS:					
Senior Managers	2	$ 22,500	$ 28,500	$ 3,000	21%
Project Managers	26	266,800	309,900	1,700	16
Senior Technicians	27	244,100	265,400	800	9
Technicians III	29	220,300	235,800	500	7
Technicians II	21	133,300	141,200	400	6
Technicians I	4	26,400	26,400	-0-	-0-
Subtotal	109	913,400	1,007,200	900	10%
ENGINEERS:					
Administrative	1	14,500	19,000	3,500	31
Executive	2	26,500	35,400	4,400	33
Senior	8	92,200	120,700	3,600	31
Project	6	65,400	73,300	1,300	12
Engineer	8	72,700	76,500	500	5
Subtotal	25	271,300	324,900	2,100	20%
Total	134	1,184,700	1,332,100	1,100	12%

Note: All figures rounded to the nearest $100

PRECONSTRUCTION
ESTIMATED FUND AVAILABILITY
June 1971

BUDGET UNIT	ACTUAL COSTS F.Y. 1970	BUDGET ESTIMATE OF COSTS F.Y. 1971	BUDGET REQUEST F.Y. 1972
Preconstruction Office	$ 188,500	$ 211,500	$ 264,200
Office Engineers	92,300	96,000	103,500
West Region	299,800	363,100	407,200
East Region	289,200	330,400	378,300
Hydraulics	60,500	54,100	58,400
Traffic	182,500	191,500	206,800
Public Hearings	33,100	34,400	37,200
Secondary Roads	39,300	19,300	20,800
Consultant Design	92,100	105,800	114,300
TOTAL SALARIES	$1,277,300	$1,406,100	$1,590,700
NUMBER OF PERSONS	164	168	178
Year-to-Year Increase:			
Dollar Amount		$ 128,800	$ 184,600
Percent		10%	13%
Number of Persons		4	10

Note: All figures rounded to the nearest $100. Estimate excludes Assistant State Highway Engineer, Project Control, Bridge, Right-of-Way, Right-of-Way Attorneys.

BIENNIUM IMPLEMENTATION COST ESTIMATE
PRECONSTRUCTION STAGE I
June 1971

Estimated Funds Available *		$ 2,812,000
Less Reserve for Contingencies		62,000
Estimated Net Funds Available		$ 2,750,000
PROJECTED BIENNIUM COSTS:		
Covered Personnel at Current Rate:		
Technicians	$1,827,000	
Engineers	542,000	2,369,000
Stage I Costs (33% of Total Increase):		
Technicians	$ 64,000	
Engineers	35,000	99,000
Costs of Persons Not Now Covered At Current Rate:		
Clerical & Others	$ 146,000	
Temporary Employees	17,000	163,000
ESTIMATED BIENNIUM COSTS WITH STAGE I		$ 2,631,000
ESTIMATED BALANCE		$ 119,000

NUMBER OF PERSONS IN ESTIMATE:

Full-time	147
Part-time	4

* Assumes a "bare-bones budget" with expenditures at estimated fiscal year 1971 rate, as estimated in current appropriation requests.

Note: All figures are rounded to the nearest thousand dollars.

TRAINING

CONTENTS

TRAINING NEEDS ANALYSIS

+ Objectives
+ Employee characteristics
+ Work analysis
+ Skills analysis
+ Test development
+ Sample selection
+ Test administration
+ Wonderlic personnel test
+ Test evaluation
+ Training program policy.

OBJECTIVES

A detailed analysis of the training needs of the Road Design personnel was conducted. The objectives of this analysis were:

1. To identify the training-related characteristics of the employees to be trained.

2. To identify the principal training needs of the Road Design personnel.

3. To develop a plan for training that best will provide the needed training with the best utilization of the dollars spent for training.

EMPLOYEE CHARACTERISTICS

The characteristics of the work force that must be considered in developing training programs are (1) the size and location of the work force to be trained, (2) their age levels, (3) their education backgrounds, and (4) their work related experience.

DISTRIBUTION OF PRECONSTRUCTION EMPLOYEES
BY SECTION
August, 1970

Section	--- TOTAL --- Number	Percent	-NUMBER OF EMPLOYEES- Engineers	Technicians And Others	Ratio of Technicians To Engineers
Road Design:					
East Region	35	22%	4	31	7.8 to 1
West Region *	40	25	10	30	3.0 to 1 *
Tracing	6	4	--	6	---
Surfacing Design	4	3	1	3	2.0 to 1
Consultant Design	9	6	2	7	3.5 to 1
Subtotal	94	59%	17	77	4.0 to 1
Traffic Engineering	22	14	5	17	3.4 to 1
Office Engineering	11	7	2	9	3.5 to 1
Hydraulics	6	4	4	2	1.0 to 2
Stereo Section	3	2	--	3	---
Administration & Supporting	16	10	4	12	1.3 to 1
Subtotal	152	96	32	120	3.4 to 1
Field Design (Full-time)	6	4	--	6	
TOTAL	158	100%	32	126	3.6 to 1
Percent of Total	100%		20%	80%	

* Ratio of Technicians to Engineers Excluding Engineers-in-Training is 6.0 to 1

DISTRIBUTION OF PERSONNEL BY AGE *

August 1970

Age Groups	Engineers		Technicians		Total	
	Number	Percent Of Total	Number	Percent Of Total	Number	Percent Of Total
20 to 40 years old	22	69%	71	63%	93	65%
41 to 55 years old	6	19	32	29	38	26
56 to 60 years old	1	3	4	4	5	3
Over 60 years old	3	9	5	4	8	6
Total	32	100%	112	100%	144	100%
Average Age	37		38		38	

* - Excludes non-engineering administrative and clerical personnel, and field design personnel.

DISTRIBUTION OF PERSONNEL BY YEARS OF EDUCATION *

August 1970

Grouped Years of Education	Engineers		Technicians		Total	
	Number	Percent Of Total	Number	Percent Of Total	Number	Percent Of Total
Less than 12 years			6	5%	6	4%
12 years	2	6%	49	44	51	36
13 to 15 years			41	36	41	28
16 years	25	78	12	11	37	26
More than 16 years	5	16	4	4	9	6
Total	32	100%	112	100%	144	100%
Average Years of Education	16		13		14	

* - Excludes non-engineering administrative and clerical personnel, and field design personnel.

DISTRIBUTION OF PERSONNEL BY AGE *

August 1970

Age Groups	Engineers		Technicians		Total	
	Number	Percent Of Total	Number	Percent Of Total	Number	Percent Of Total
20 to 40 years old	22	69%	71	63%	93	65%
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Over 60 years old	3	9	5	4	8	6
Total	32	100%	112	100%	144	100%
Average Age	37		38		38	

* - Excludes non-engineering administrative and clerical personnel, and field design personnel.

DISTRIBUTION OF PERSONNEL BY YEARS OF EDUCATION *

August 1970

Grouped Years of Education	Engineers		Technicians		Total	
	Number	Percent Of Total	Number	Percent Of Total	Number	Percent Of Total
Less than 12 years			6	5%	6	4%
12 years	2	6%	49	44	51	36
13 to 15 years			41	36	41	28
16 years	25	78	12	11	37	26
More than 16 years	5	16	4	4	9	6
Total	32	100%	112	100%	144	100%
Average Years of Education	16		13		14	

* - Excludes non-engineering administrative and clerical personnel, and field design personnel.

DISTRIBUTION OF PERSONNEL BY YEARS OF DEPARTMENT EXPERIENCE *

August 1970

Grouped Years of Department Experience	Engineers		Technicians		Total	
	Number	Percent Of Total	Number	Percent Of Total	Number	Percent Of Total
Less than 1 year	5	16%	3	3%	8	5%
1 to 5 years	13	41	40	36	53	37
6 to 15 years	8	25	41	36	49	34
16 to 25 years	2	6	25	22	27	19
Over 25 years	4	12	3	3	7	5
Total	32	100%	112	100%	144	100%
Average Years Experience	18		10			

* - Excludes non-engineering administrative and clerical personnel and field design personnel.

DISTRIBUTION OF ENGINEERS
BY AGE
August 1970

Personnel Classification	Number of Employees					Average Age
	Total	20 to 40 Years Old	41 to 55 Years Old	56 to 60 Years Old	Over 60 Years Old	
Section Heads and Above (G-26 to 32)	10	4	3	1	2	48
Asst. Section Heads (G-24)	6	5	1		1	36
Designer III (G-23)	4	1	2		1	48
Designer II and Comparable (G-21)	5	5				31
Engineer-In-Training (G-19)	7	7				25
Total--Engineers	32	22	6	1	3	37
Percent Distribution	100%	69	19	3	9	
Average Age	37	30	51	58	63	

DISTRIBUTION OF ENGINEERS
BY YEARS OF EDUCATION
August 1970

Personnel Classification	Number of Employees				Average Years Education
	Total	12 Years	16 Years	17 Years Or More	
Section Heads and Above (G-26 to 32)	10	2	7	1	15
Asst. Section Heads (G-24)	6		5	1	16
Designer III (G-23)	4		4		16
Designer II and Comparable (G-21)	5		5		16
Engineer-in-Training (G-19)	7		4	3	16
Total--Engineers	32	2	25	5	16
Percent Distribution	100%	6	78	16	
Average Years Education	16	12	16	17	

DISTRIBUTION OF ENGINEERS
BY YEARS OF DEPARTMENT EXPERIENCE
August 1970

Personnel Classification	Number of Employees: Total	Less Than 1 Year	1 to 5 Years	6 to 15 Years	16 to 25 Years	Over 25 Years	Average Years Experience
Section Heads and Above (G-26 to 32)	10		1	5	1	3	18
Asst. Section Heads (G-24)	6		4	1	1		7
Designer III (G-23)	4		2	1		1	11
Designer II and Comparable (G-21)	5		4	1			5
Engineer-In-Training (G-19)	7	5	2				*
Total--Engineers	32	5	13	8	2	4	9
Percent Distribution	100	16	41	25	6	12	
Average Years Experience	9		3	11	24	37	

* Less than one year.

DISTRIBUTION OF ENGINEERS
BY YEARS OF NON-DEPARTMENT EXPERIENCE
RELATED TO CURRENT ASSIGNMENTS
August, 1970

Personnel Classification	Number of Employees					Average Years Experience
	Total	Less Than 1 Year	1 to 5 Years	6 to 15 Years	16 to 25 Years	
Section Heads and Above (G-26 to 32)	10	2	6		2	5
Asst. Section Heads (G-24)	6	3	3			2
Designer III (G-23)	4	2		1	1	7
Designer II and Comparable (G-21)	5	3	2			1
Engineer-In-Training (G-19)	7	6	1			1
Total -- Engineers	32	16	12	1	3	3
Percent Distribution	100%	50	38	3	9	
Average Years Experience	3	0	3	6	18	

DISTRIBUTION OF TECHNICIANS
BY AGE
August 1970

Personnel Classification	Number of Employees					Average Age
	Total	20 to 40 Years Old	41 to 55 Years Old	56 to 60 Years Old	Over 60 Years Old	
Designer III and Above (G-23 and 24)	16	6	9	1		44
Designer II and Estimates Supervisor II (G-20 and 21)	14	6	6	1	1	44
Designer I and Comparable (G-19)	17	11	4	1	1	42
Detailer I and Estimates Supervisor I (G-17)	17	10	7			37
Draftsman III and Plotter I (G-15)	23	13	6	1	3	41
Draftsman II and I (G-13 and 11)	24	24				22
Total--Technicians	111	70	32	4	5	38
Percent Distribution	100	63	29	4	4	
Average Age	38	29	48	58	63	

DISTRIBUTION OF TECHNICIANS
BY YEARS OF EDUCATION
August 1970

Personnel Classification	NUMBER OF EMPLOYEES						Average Years Of Education
	Total	Less Than 12 Years	12 Years	13 to 15 Years	16 Years	More Than 16 Years	
Designer III and Above (G-23 and 24)	16	2	7	6	1		12
Designer II and Estimates Supervisor II (G-20 and 21)	14	2	8	1	1	2	13
Designer I and Comparable (G-19)	17	1	9	4	3		13
Detailer I and Estimates Supervisor I (G-17)	17		6	6	5		14
Draftsman III and Plotter I (G-15)	23	1	9	11	1	1	13
Draftsman II and I (G-13 and 11)	24		10	12	1	1	13
Total -- Technicians	111	6	49	40	12	4	13
Percent Distribution	100	5	44	36	11	4	
Average Years of Education	13	9	12	14	16	17	

DISTRIBUTION OF TECHNICIANS
BY YEARS OF DEPARTMENT EXPERIENCE
August 1970

Personnel Classification	NUMBER OF EMPLOYEES						Average Years Of Experience
	Total	Less Than 1 Year	1 to 5 Years	6 to 15 Years	16 to 25 Years	Over 25 Years	
Designer III and Above (G-23 and 24)	16		1	2	13		18
Designer II and Estimates Supervisor II (G-20 and 21)	14			8	5	1	17
Designer I and Comparable (G-19)	17		2	13	2		12
Detailer I and Estimates Supervisor I (G-17)	17		5	8	3	1	9
Draftsman III and Plotter I (G-15)	23		12	8	2	1	9
Draftsman II and I (G-13 and 11)	24	3	20	1			
Total -- Technicians	111	3	40	40	25	3	10
Percent Distribution	100	3	36	36	22	3	
Average Years of Experience	10	10	2	12	21	29	

DISTRIBUTION OF TECHNICIANS
BY YEARS OF NON-DEPARTMENT EXPERIENCE
RELATED TO CURRENT ASSIGNMENTS
August 1970

Personnel Classification	Number of Employees: Total	Less Than 1 Year	1 to 5 Years	6 to 15 Years	16 to 25 Years	Average Years Experience
Designer III and Above (G-23 and 24)	16	11	1	3	1	3
Designer II and Estimates Supervisor II (G-20 and 21)	14	9	4	1		2
Designer I and Comparable (G-19)	17	9	3	2	3	4
Detailer I and Estimates Supervisor I (G-17)	17	4	7	5	1	5
Draftsman III and Plotter I (G-15)	23	15	4	3	1	2
Draftsman II and I (G-13 and 11)	24	11	13			1
Total -- Technicians	111	59	32	14	6	3
Percent Distribution	100	53	29	13	5	
Average Years Experience	3		2	9	19	

DISTRIBUTION OF FIELD DESIGN TECHNICIANS
BY AGE
March 1970

Personnel Classification	Number of Employees				
	Total	20 to 40 Years Old	41 to 55 Years Old	Over 60 Years Old	Average Age
Designer II (G-21)	2		1	1	59
Detailer II (G-19)	2	1	1		38
Draftsman III (G-15)	2	1	1		42
Total--Field Design	6	2	3	1	46
Average Age	46	37	49	64	

DISTRIBUTION OF FIELD DESIGN TECHNICIANS
BY YEARS OF EDUCATION
August 1970

Personnel Classification	Total	12 Years	Average Years Education
Designer II (G-21)	2	2	12
Detailer II (G-19)	2	2	12
Draftsman III (G-15)	2	2	12
Total--Field Design	6	6	12

DISTRIBUTION OF FIELD DESIGN TECHNICIANS
BY YEARS OF DEPARTMENT EXPERIENCE
August 1970

Personnel Classification	Total	6 to 15 Years	16 to 25 Years	Over 25 Years	Average Years Experience
Designer (G-21)	2			2	29
Detailer II (G-19)	2	1	1		14
Draftsman III (G-15)	2	2			8
Total--Field Design	6	3	1	2	17

WORK ANALYSIS

The road design function involves the performance of over 250 identifiable tasks which can be characterized by 37 activity statements. The characteristics and work requirements of several tasks are grouped and represented by an activity statement. The major activities identified for the road design function are shown.

ACTIVITY TITLES

REPRESENTING THE ROAD DESIGN FUNCTION

Number	Activity Title
1	Checking Notes Preparatory to Plotting
2	Plotting Survey Data -- Aerial and Land
3	Plotting Cross Sections
4	Templating Cross Sections
5	Designing Typical Sections
6	Designing Alignment and Grade
7	Computing Grade Lines
8	Designing Intersection, Rest Area, Scale and Interchange Geometrics
9	Designing Contour Grading
10	Designing Miscellaneous Features
11	Designing Clearing and Grubbing Details
12	Designing Fencing
13	Plotting Drainage on Plan and Profile
14	Designing Drainage
15	Preparing Preliminary Estimates
16	Preparing Displays and Illustrations
17	Participating in Field Trips
18	Computing Areas
19	Computing Right-of-Way Areas of Taking
20	Computing Earthwork Quantities (by Hand)
21	Plotting Mass Diagrams
22	Totaling Final Quantities
23	Writing Preliminary Special Provisions
24	Inking Final Plans and Tracing
25	Coding Basic Computer Inputs
26	Coding Complex Computer Inputs
27	Checking and Interpreting Computer Outputs
28	Cross-Checking Structure and Road Plans
29	Extending Estimates and Quantities

ACTIVITY TITLES
REPRESENTING THE ROAD DESIGN FUNCTION
(Continued)

Number	Activity Title
30	Plotting Construction Limits
31	Preparing Right-of-Way Linens
32	Preparing Right-of-Way Sepia
33	Interpreting and Plotting Property Lines
34	Designing Right-of-Way Limits
35	Preparing Utility Plans
36	Reviewing Consultant Agreements
37	Checking and Reviewing Plans

SKILLS ANALYSIS

Satisfactory performance of all 37 activities required different combinations and degrees of knowledges, skills and abilities (KSA's).

A total of 26 knowledge, skill and ability statements were defined. A typical knowledge, skill and ability -- Mathematics One -- is shown.

ROAD DESIGN

KNOWLEDGE, SKILL AND ABILITY STATEMENT TITLES

Statement Title	Statement Number
Mathematics One	1
Mathematics Two	2
Mathematics Three	3
Basic Survey Interpretation	4
Advanced Survey Interpretation	5
Plan Reading	6
Basic Drafting	7
Advanced Drafting	8
Manuals of Reference	9
Template Cross Sections	10
Code Basic Computer Inputs	11
Code Complex Computer Inputs	12
Prepare Utility Plans	13
Design Typical Sections	14
Design Alignment and Grade	15
Design Intersection, Rest Area, Scale and Interchange Geometrics	16
Design Contour Grading	17
Design Mass Diagram	18
Design Fencing	19
Design Drainage	20
Design Right-of-Way Limits	21
Design Miscellaneous Features	22
Write Preliminary Special Provisions	23
Prepare Preliminary Estimates	24
Check and Review Plans	25
Cross Check Structure and Road Plans	26

A TYPICAL KNOWLEDGE, SKILL AND ABILITY STATEMENT

MATHEMATICS ONE

Knowledge

1. Of the arithemetic used in working with whole, fractional and decimal numbers.

2. Of the procedures followed to convert fractions to decimals and decimals to fractions.

3. Of the rules followed in rounding decimal and fractional numbers.

4. Of the basic rules regarding the "significance of numbers".

Skill

1. In adding machine or calculator operation.

Ability

1. To add, subtract, multiply and divide whole, fractional and decimal numbers accurately and quickly.

2. To calculate percentages.

3. To relate numbers to each other as ratios.

TEST DEVELOPMENT

Work-orientated test questions were developed for each of the knowledge, skill and ability statements.

Examples of the test questions defined are as follows:

1. The ratio of the horizontal distance to the vertical distance on a slope is 24 feet to 4 feet. The slope, expressed as a ratio is _____?

2. How many acres are contained in a parcel of land described as NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 23?

3. (Complete the blank) On an input form DPS-E60 (Horizontal Alignment and Offsets) an entry in column 25 designates a _____ equation.

Both written test questions and performance test questions were developed. Whenever possible performance questions were developed in preference to written questions including multiple-choice, blank completion, and narrative replies. It was appropriate to test the basic and advanced drafting statements, for example, using performance questions requiring personnel to actually draw, scale, dimension and letter.

To insure that the test questions were job-related, a committee of Department personnel developed most of the questions and the Consultant organized them into test form. Particular attention was given to the following:

1. Each performance question was a sample of the work actually done.

2. Each written question was highly job-related.

3. Each question was set forth clearly with little doubt as to what was wanted.

4. No "trick" questions were utilized.

The Committee reviewed the final tests to insure that every question was appropriate to the KSA requirements of the activity statement and that the employees would have no difficulty understanding the question.

SAMPLE SELECTION

A random sample of the road design personnel was selected. Thirteen employees representing more than 17 percent of the work force were selected to take the test questions. Efforts were made to insure that the sample was representative of the total road design work force. The comparisons of the total road work force and the sample characteristics relative to (1) size of sample, (2) age, (3) education, and (4) experience characteristics are shown.

COMPARISON OF ROAD DESIGN WORK FORCE

AND SAMPLE CHARACTERISTICS

Personnel Classification	Total Road Design Force	Sample Characteristics	
		Number Tested	Percent of Total Force
Designer II and III	22	4	18.2%
Detailer I and II, and Designer I	21	4	19.0
Draftsman I, II and III	32	5	15.6
Total	75	13	
Sample Size (In Percent)			17.3%

DISTRIBUTION OF ROAD DESIGN PERSONNEL ACCORDING TO AGE[1]

Personnel Classification	ROAD DESIGN FORCE[2]		SAMPLE CHARACTERISTICS	
	Total Number	Average Age	Total Number	Average Age
Designer III	14	45	1	40
Designer II	8	43	3	42
Designer I	11	45	3	49
Detailer II	1	38	0	
Detailer I	9	39	1	45
Draftsman III	16	42	3	28
Draftsman II	15	25	2	23
Draftsman I	1	20	0	
Total	75		13	
Average Age		39		38

[1] Excludes non-engineering administrative and clerical personnel, and field design personnel.

[2] Based on the manpower inventory taken August 1970.

DISTRIBUTION OF ROAD DESIGN PERSONNEL ACCORDING TO EDUCATION [1]

Personnel Classification	ROAD DESIGN FORCE [2]		SAMPLE CHARACTERISTICS	
	Total Number	Average Years Of Education	Total Number	Average Years Of Education
Designer III	14	11	1	12
Designer II	8	14	3	14
Designer I	11	12	3	14
Detailer II	1	12	0	
Detailer I	9	13	1	12
Draftsman III	16	13	3	13
Draftsman II	15	13	2	14
Draftsman I	1	12	0	
Total	75		13	
Average Years of Education		13		13

[1] Excludes non-engineering administrative and clerical personnel, and field design personnel.

[2] Based on the manpower inventory taken August, 1970.

DISTRIBUTION OF ROAD DESIGN PERSONNEL ACCORDING TO EXPERIENCE[1]

Personnel Classification	ROAD DESIGN FORCE[2]		SAMPLE CHARACTERISTICS	
	Total Number	Average Years Of Experience	Total Number	Average Years Of Experience
Designer III	14	18	1	23
Designer II	8	16	3	18
Designer I	11	13	3	11
Detailer II	1	15	0	
Detailer I	9	11	1	11
Draftsman III	16	11	3	7
Draftsman II	15	2	2	2
Draftsman I	1	1	0	
Total	75		13	
Average Years of Experience		11		11

[1] Excludes non-engineering administrative and clerical personnel, and field design personnel.

[2] Based on the manpower inventory taken August, 1970.

TEST ADMINISTRATION

The supervisors of the personnel in the sample were asked to define for each employee (1) those specific test sections which the employees were required to know in the performance of his work, and (2) those test sections which he would expect the employee to know in the very near-future. In addition the supervisors were asked to evaluate the needs of each employee for each test section. This supervisory evaluation provided the basis for the test administration in that each employee was required to take only those sections identified for him.

The test was administered to the personnel during working hours. To make certain that every employee would answer as many questions as he was able, the following steps were taken:

1. Every employee was assigned an identification number known only to the Consultant.

2. The employees were assured that the test booklet for an individual would not be scored and a "grade" given. In addition the employees were assured that test results would not be reflected in salary or promotion considerations.

3. The tests were administered by the Committee and Consultant personnel.

4. The employees were allowed to bring any reference book which they normally used at the work place.

5. A complete explanation of the purposes and methods of training needs analysis was given.

WONDERLIC PERSONNEL TEST

The Wonderlic Personnel Test was administered to obtain an indication of the capacities of the individuals in the sample to assimilate training. This test was selected because it is widely used as a basis for screening candidates for employment and because its validity and reliability characteristics have been confirmed repeatedly.

The test consists of 50 questions and require that each person demonstrates his relative capacity to work with words, numbers, clerical data, statements in logic and simple problems in geometry. The questions proceed from the simple to the more complex. The participant is given 12 minutes to answer as many questions as possible and his score is determined by the number of correct answers. The following guidelines serve for the interpretation of test scores:

1. Any score can have been affected by difficulty with the written English language.

2. Scores of 1 to 6 indicate very limited capacities to learn.

3. Scores of 7 to 11 indicate capacities to learn equivalent to those needed as truck drivers, messengers and supervisors of common laborers.

4. Scores of 12 to 17 indicate capabilities to perform repetitive assignments such as tracing, or plotting cross-sections.

5. Scores of 18 and above indicate the capacities to learn the more difficult phases of repetitive design where standards, policies and procedures are used as bases for decisions.

DISTRIBUTION OF ROAD DESIGN PERSONNEL

ACCORDING TO WONDERLIC TEST SCORES

August, 1971

Personnel Classification	Number of Personnel Tested	SCORE DISTRIBTUTION						Average Score
		0 to 6	7 to 11	12 to 17	18 to 23	24 to 29	above 30	
Designer III and II	4				1	2	1	26
Designer I and Detailer I	4			1	2		1	23
Draftsman III and II	5	—	—	—	4	1	—	22
Total	13	0	0	1	7	3	2	
Total Average Score								23.5

6. Scores of 24 and above indicate capacities to learn engineering.

7. Scores of 30 and above indicate capacities to learn the techniques of research.

Interpretations must be made with care and judgement since capacity to learn is affected by willingness and motivation to learn. However, the probable characteristics of the trainee group can be hypothesized relative to ability to read and comprehend the written word and to work with given data in pursuit of an answer.

TEST EVALUATION

The tests and evaluations were scored by the project staff and reflect the existing knowledge-skill-ability levels of the employees tested. Three groups of needs were identified indicating (1) a high priority need, (2) a low priority need (training could be valuable, if available), and (3) no training need.

The results derived from the sample group were used to estimate the training needs of the entire road design work force.

In the tabulations shown on the following pages only high priority training needs were tabulated. Those persons showing low priority needs -- that is they would benefit from training if available -- were excluded from the tabulations.

TEST AND EVALUATION RESULTS

TRAINING NEEDS ESTIMATES

Common KSA Statements

KSA Statement	Sample Results: Persons Tested [1]	Sample Results: Percent of Sample	Sample Results: Number Needing Training	Sample Results: Percent of Sample Needing Training	Estimates [2]: Applicable Personnel	Estimates [2]: Persons Needing Training
Mathematics One	13	100%	5	39%	75	30
Mathematics Two	13	100	7	54	75	40
Mathematics Three	6	46	3	50	34	16
Basic Survey Interpretation	13	100	6	46	75	34
Advanced Survey Interpretation	8	62	0	0	46	0
Plan Reading	13	100	4	31	75	24
Basic Drafting	13	100	4	31	75	24
Advanced Drafting	7	54	5	71	40	28
Manuals of Reference	13	100	10	77	75	58

[1] The test group included 13 persons. Less than 13 persons are shown to have been tested on certain KSA's because all individuals in the sample were not required to take all sections.

[2] Based on 75 persons in Road Design. All estimates have been rounded to the nearest even number of personnel to simplify the analysis and to emphasize that the figures are estimates.

TEST AND EVALUATION RESULTS

TRAINING NEEDS ESTIMATES

Computer Utilization Statements

KSA Statement	Sample Results				Estimates 2/	
	Persons Tested 1/	Percent of Sample	Number Needing Training	Percent of Sample Needing Training	Applicable Personnel	Persons Needing Training
Code Basic Computer Inputs	8	62%	6	75%	46	34
Code Complex Computer Inputs	4	31	3	75	24	18

1/ The test group included 13 persons. Less than 13 persons are shown to have been tested on certain KSA's because all individuals in the sample were not required to take all sections.

2/ Based on 75 persons in Road Design. All estimates have been rounded to the nearest even number of personnel to simplify the analysis and to emphasize that the figures are estimates.

TEST AND EVALUATION RESULTS

TRAINING NEEDS ESTIMATES

Right-of-Way and Utility Statements

KSA Statement	Sample Results: Persons Tested[1]	Sample Results: Percent of Sample	Sample Results: Number Needing Training	Sample Results: Percent of Sample Needing Training	Estimates[2]: Applicable Personnel	Estimates[2]: Persons Needing Training
Prepare Utility Plans	3	23%	1	33%	12	4
Design Fencing	3	23	2	67	12	8
Design Right-of-Way Limits	2	15	1	50	12	6

[1] The test group included 13 persons. Less than 13 persons are shown to have been tested on certain KSA's because all individuals in the sample were not required to take all sections.

[2] Based on 12 persons in Road Design. All estimates have been rounded to the nearest even number of personnel to simplify the analysis and to emphasize that the figures are estimates.

TEST AND EVALUATION RESULTS

TRAINING NEEDS ESTIMATES

Design Statements

KSA Statement	Sample Results				Estimates [2]	
	Persons Tested	Percent of Sample [1]	Number Needing Training	Percent of Sample Needing Training	Applicable Personnel	Persons Needing Training
Template Cross Sections	10	77%	6	60%	48	28
Design Typical Sections	6	46	4	67	28	18
Design Alignment and Grade	4	31	0	0	20	0
Design Intersections, Rest Area Scale and Interchange Geometrics	4	31	1	25	20	4
Design Contour Grading	6	46	3	50	28	14
Design Mass Diagram	6	46	3	50	28	14
Design Drainage	6	46	2	33	28	10
Design Miscellaneous Features	6	46	3	50	28	14
Write Preliminary Special Provisions	4	31	3	75	20	14
Prepare Preliminary Estimates	8	62	7	88	40	36
Check and Review Plans	4	31	2	50	20	10
Cross-check Structure and Road Plans	6	46	4	67	28	18

[1] The test group included 13 persons. Less than 13 persons are shown to have been tested on certain KSA's because all individuals in the sample were not required to take all sections.

[2] Based on 63 persons in Road Design. All estimates have been rounded to the nearest even number of personnel to simplify the analysis and to emphasize that the figures are estimates.

POLICY

TRAINING PROGRAM

Date Issued

POLICY

A training program will be developed to provide the information that employees need to know in order to perform work satisfactorily. The program will provide bases for the following:

1. To conduct studies to quantify training needs, identify deficient subject matter areas, and develop priorities for training based on those studies,

2. To analyze each deficient area and develop a recommended plan to overcome the need through multi-state participation, Department training material development, utilization of consultants, or by a change in the procedures that may eliminate the training need,

3. To determine the capabilities of the personnel to assimilate training,

4. To develop the appropriate training materials,

5. To determine the training needs of the individual employees and to assign and schedule training as required,

6. To modify the training methods and materials in use as necessary to keep them up to date.

POLICY

TRAINING PROGRAM

Date Issued

SCOPE: The approved program will constitute the objectives of the Department in the training of personnel. The objectives of the Training Program are as follows:

1. To ensure uniformity of practice wherever possible throughout the Department, and

2. To ensure understanding of the adopted policies and procedures by all participating personnel, and capability of those personnel to apply them.

RESPONSIBILITY:

The Manager, Training Unit will determine the training needs of personnel, assign priorities for training materials development, and recommend the Training Program to the State Highway Engineer.

The State Highway Engineer will review and approve the Training Program.

PROJECT WORK PLAN

CONTENTS

ORIGINAL PROJECT SCHEDULE

+ Summary schedule

+ Detailed schedule by phase

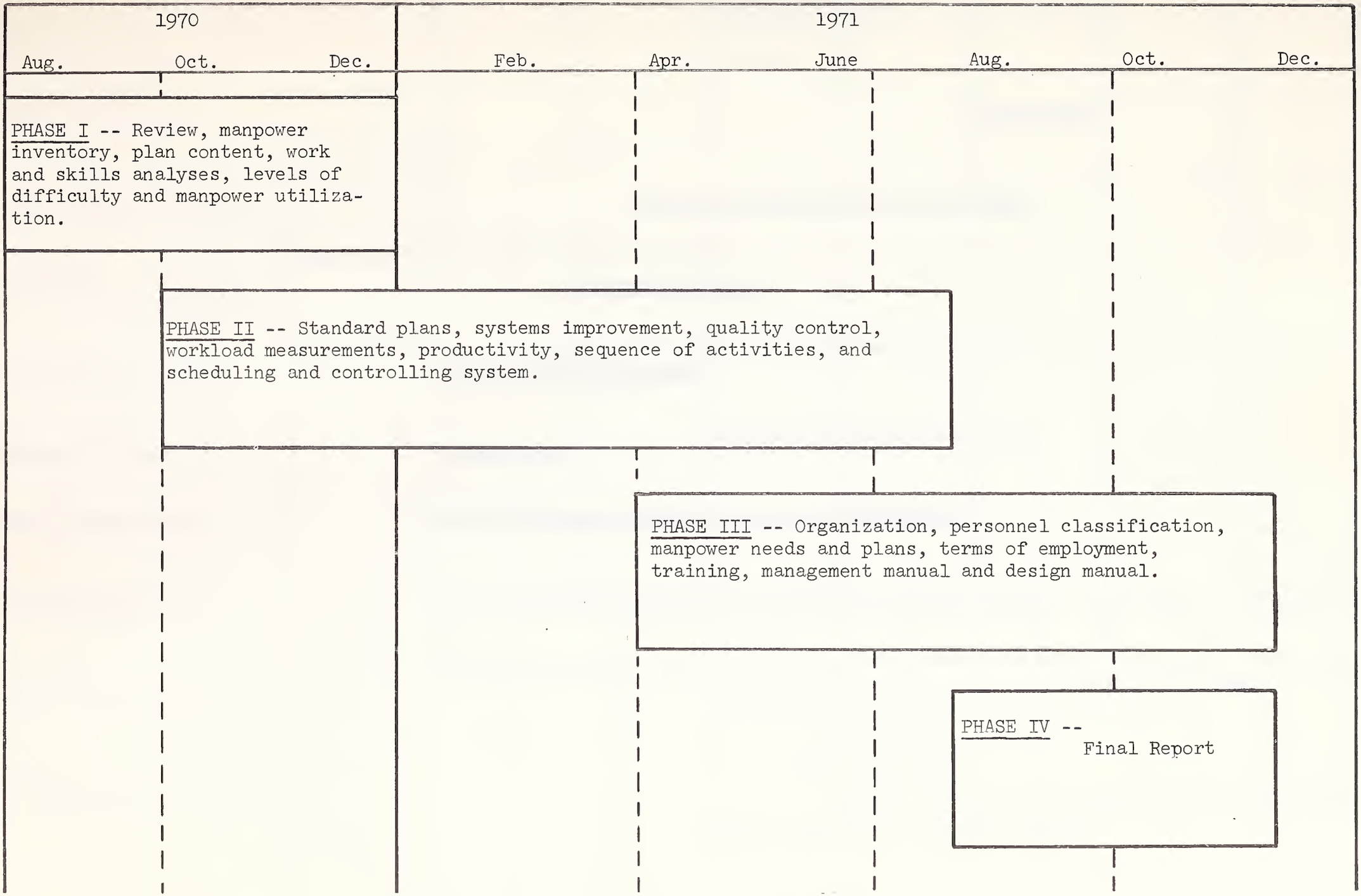
REVISED WORK PLAN

ORIGINAL PROJECT

SCHEDULES

DESIGN MANAGEMENT RESEARCH PROJECT

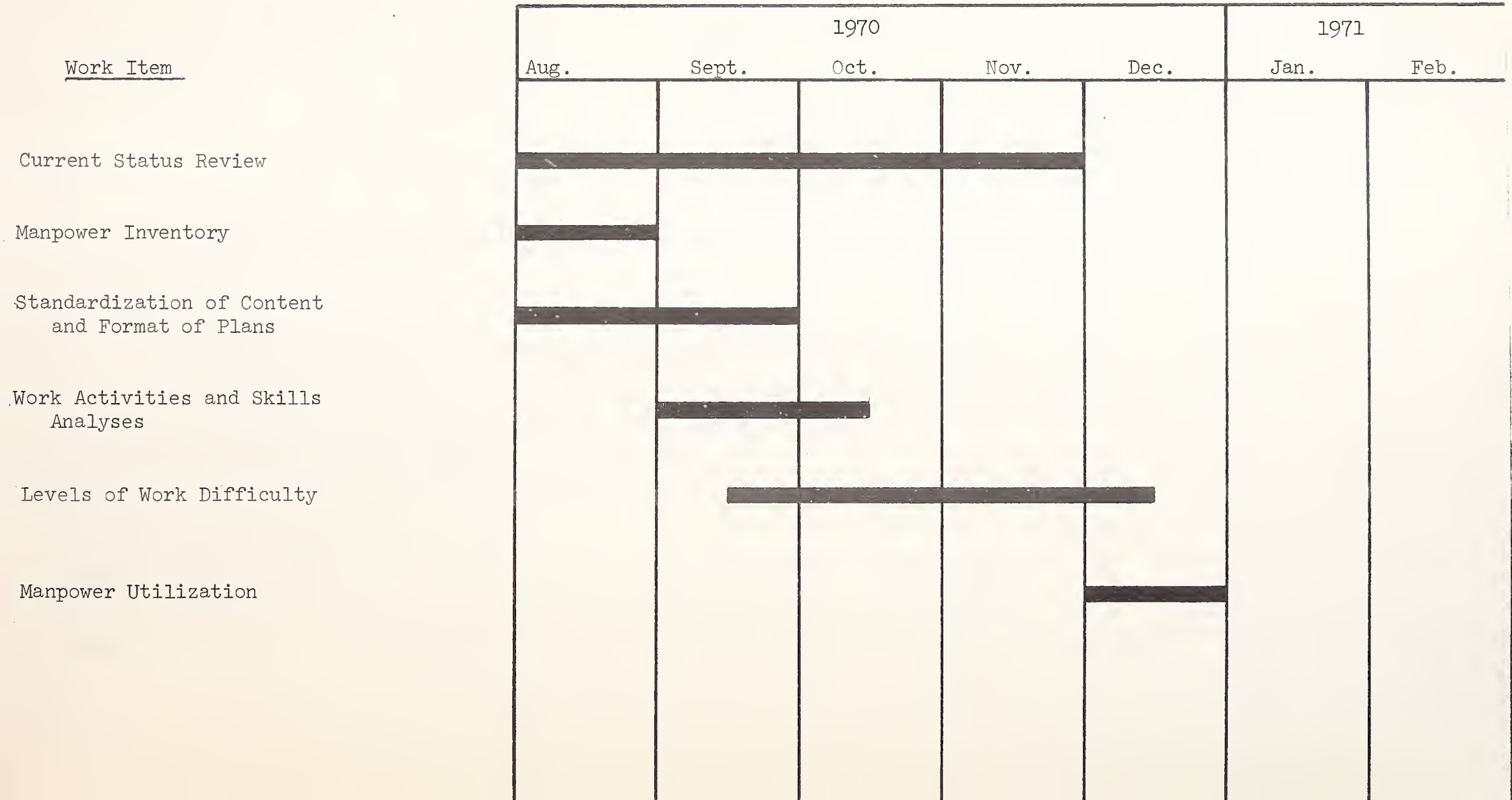
SUMMARY SCHEDULE


1970
1971
Aug.
Oct.
Dec.
Feb.
Apr.
June
Aug.
Oct.
Dec.
PHASE I -- Review, manpower inventory, plan content, work and skills analyses, levels of difficulty and manpower utilization.
PHASE II -- Standard plans, systems improvement, quality control, workload measurements, productivity, sequence of activities, and scheduling and controlling system.
PHASE III -- Organization, personnel classification, manpower needs and plans, terms of employment, training, management manual and design manual.
PHASE IV -- Final Report

DESIGN MANAGEMENT RESEARCH PROJECT

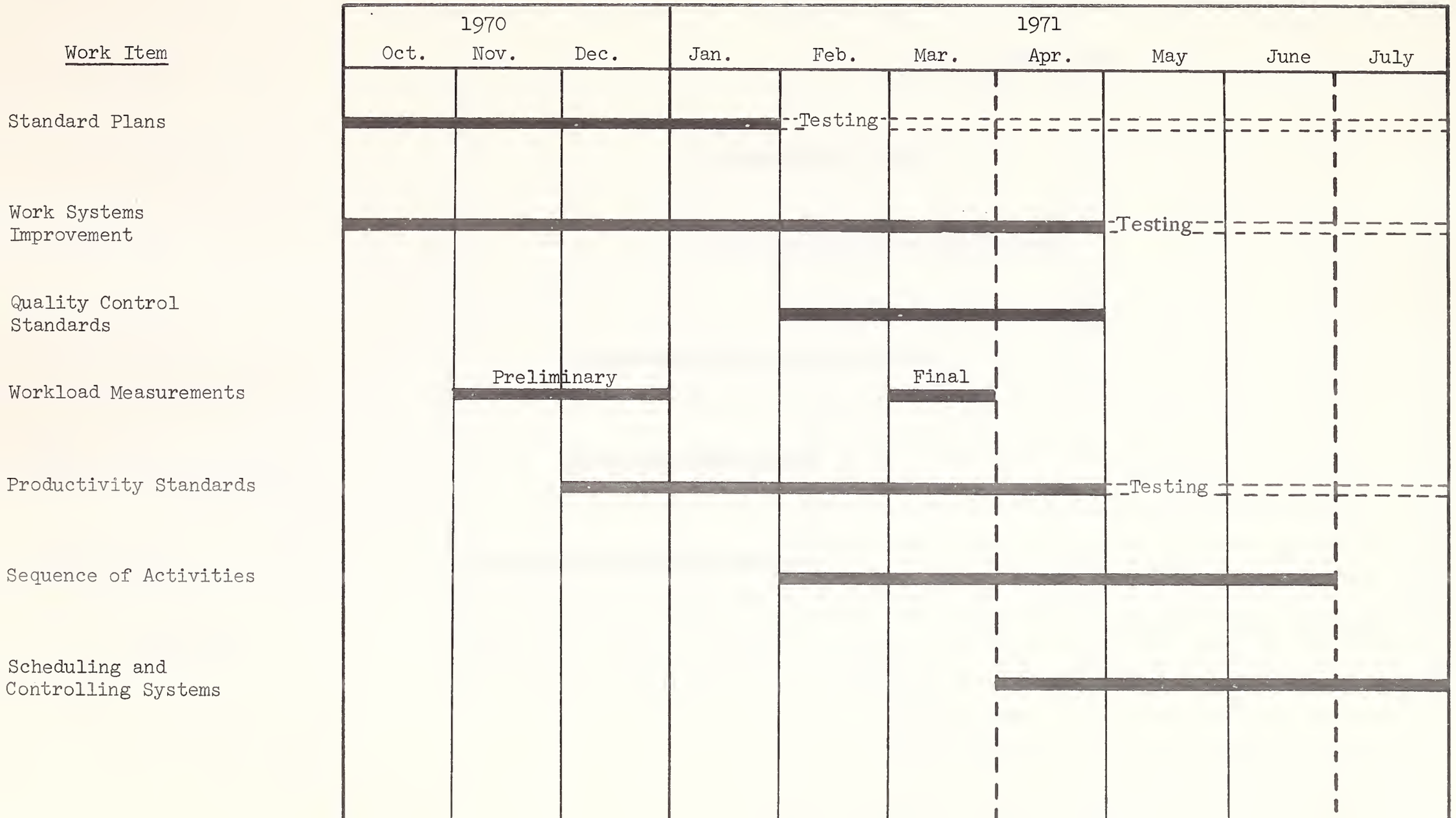
PHASE I
DETAIL SCHEDULE

August, 1970



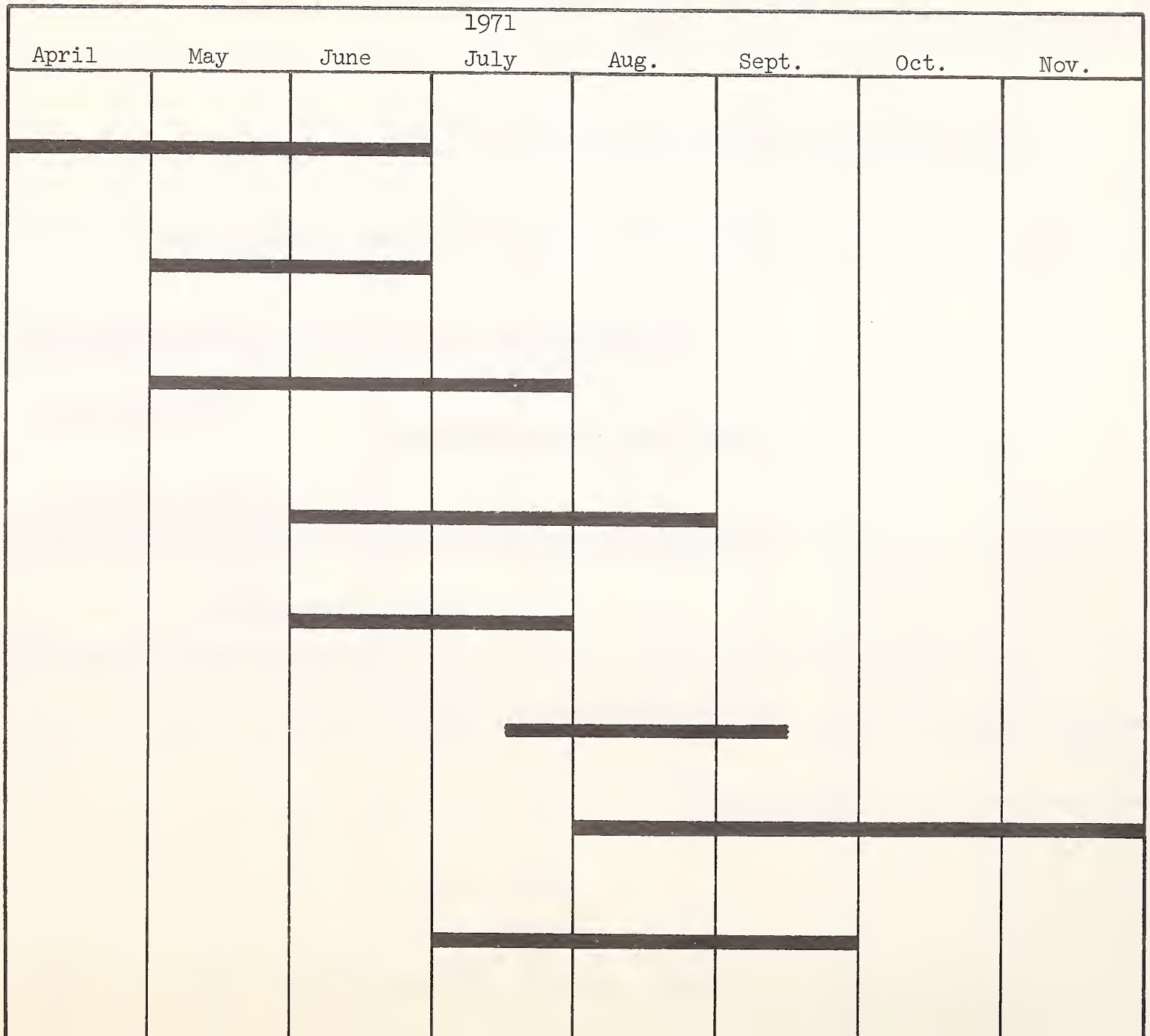
DESIGN MANAGEMENT RESEARCH PROJECT
PHASE II
DETAIL SCHEDULE

August, 1970



DESIGN MANAGEMENT RESEARCH PROJECT

PHASE III
DETAIL SCHEDULE
August, 1970



REVISED WORK PLAN

The following diagram indicates the relationships between the major work elements as determined through the experience of the project staff.

The diagram would serve as a basis for the scheduling of a similiar undertaking. However, the scope of the proposed project and the existing Department situation would have to be taken into consideration in the development of a specific project schedule.

Figure 17

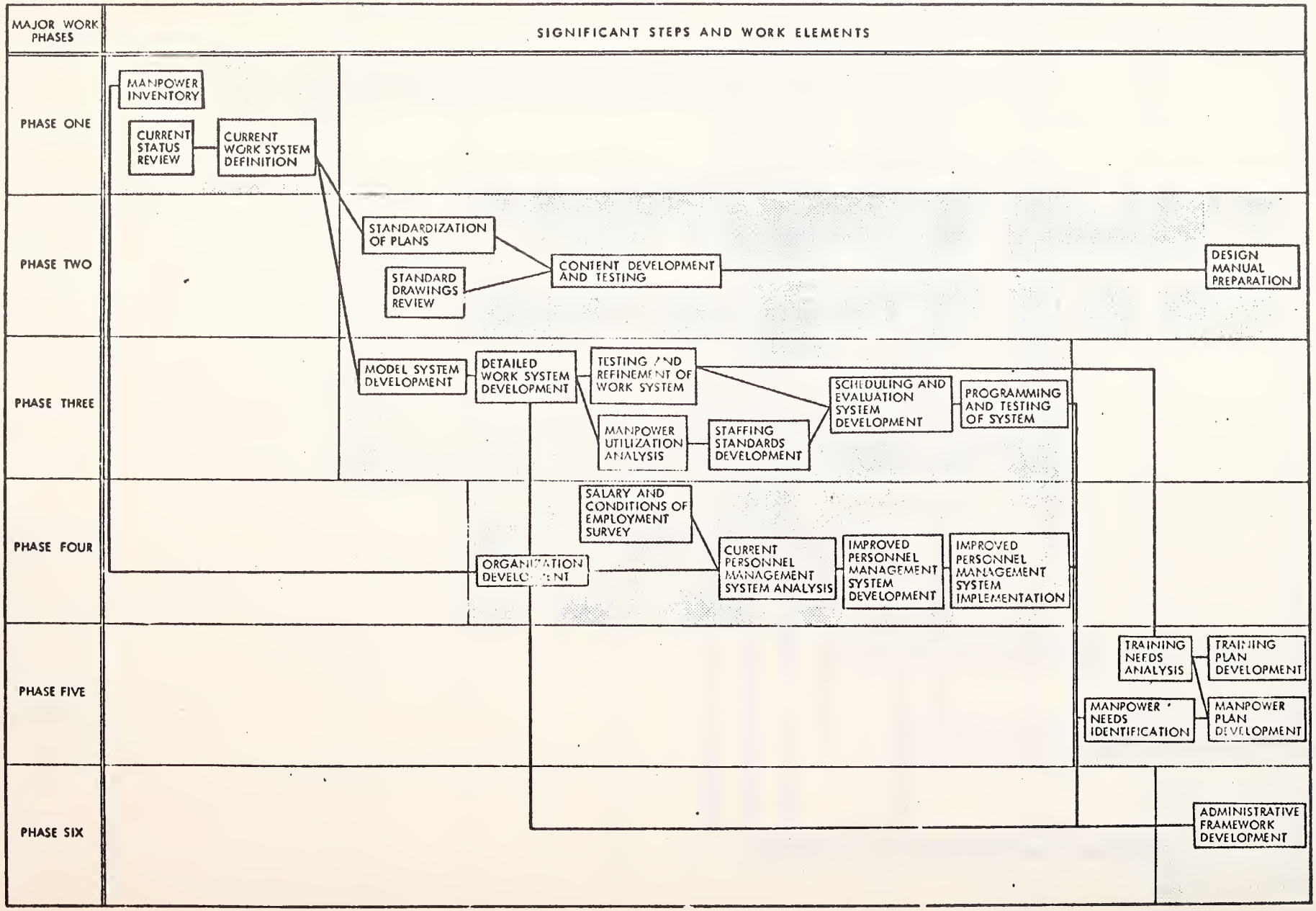



DIAGRAM OF THE REVISED WORK PLAN FOR THE DEVELOPMENT OF A DESIGN MANAGEMENT SYSTEM